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# Developing an In-House IPMS For the Hellenic Navy Gunboats

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## Abstract.

It is widely accepted that mil-spec systems are very reliable even under harsh battle conditions. However, their incomparably high cost leads most navies to adopt cheaper commercial products of lower quality. Such compromise turned out to be quite unsatisfactory for the Hellenic Navy, as commercial systems still seem overpriced and rarely live up to its expectations. In an attempt to cope with this problem, the Hellenic Navy began developing its own systems at minimal cost and with surprisingly good results. In this paper, the "έποψις" (epopsis) Integrated Platform Management System installed onboard the POLEMISTIS-class gunboats is presented.

**Keywords:** IPMS, έποψις (epopsis), in-house, SCADA, monitoring, control.

## 1 Introduction

The POLEMISTIS-class gunboats are very reliable and efficient ships, designed / built in Greece and commissioned in 1994. They have a length of 56.5m and a displacement of 595tn. However – like all ships – as they get older, some of their systems become obsolete and / or harder to maintain.

The Integrated Platform Management System (IPMS) is an extensive electronic system that monitors and controls the platform (engines, generators, auxiliaries etc) of

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a ship. The original IPMSs installed onboard the POLEMISTIS-class gunboats were frequently malfunctioning. Furthermore, their manufacturer had gone out of business, so no technical support or spare parts were available any more. Other companies had offered to provide limited support, but at very high cost. After taking into account that the specific IPMS was also quite hard to operate and offered very few features, it became clear that it had to be replaced.

Purchasing and installing new mil-spec IPMSs was out of the question, as their cost was in the millions of euros.

Commercial products did not seem very appealing either, because in the past, implementations of this magnitude, by various companies, turned out to have several major disadvantages. In spite of their somewhat ruggedized enclosures, they often malfunctioned because they greatly relied on regular desktop PC hardware. Their most sensitive parts were the hard drives, the mechanical parts of which were not resilient enough to withstand the ship's vibrations for long. Also, their magnetic surfaces were not adequately protected against the ship's magnetic fields, often resulting in data loss. Another weakness was the gathering of dust and moisture in the cooling fans, which would often get blocked resulting in overheated and burned CPUs and motherboards. The solution suggested by the manufacturers was to replace every PC, with a reconditioned one, every 5 years.

But hardware was not the only problem. The equipment would crash when overloaded by many sensor data, or every few days for no apparent reason. The cause was that their operating systems were designed basically for office applications and as such they did not provide enough stability.

After every crash, the whole system had to be shutdown using a specific procedure to avoid further data loss and then restarted using a sequence that lasted 20 to 25 minutes. During this time, the ship had to be monitored and controlled manually from the engineering spaces. This resulted in a significant slowdown of the platform's operations, which is unacceptable during peacetime and probably fatal during battle.

In spite of all these, the initial cost of such system was about 1 mil € per ship, while spare parts and technical assistance from the manufacturer skyrocketed its life cycle cost.

## 2 A Homemade Product

After careful consideration of the above, the Hellenic Navy attempted to design, construct and install an IPMS based solely on its own resources. A previous smaller-scale project had been successfully implemented onboard the Elli-class ('S'-class) frigates a few years back ([1]).

The new IPMS, of the POLEMISTIS-class gunboats, was named epopsis ("έποψις"), which in Greek means overview. It took only one person about 6 months of consolidated work to complete this project – from the initial design to the Sea Acceptance Trials (SAT). Nevertheless, the assistance of two crewmembers of the HS POLEMISTIS during the final installation phase must also be acknowledged.

## 3 Basic Features

Like all IPMSs, the epopsis monitors the ship's platform by receiving a few hundred analog and digital signals from its sensors. Such signals are temperatures, pressures, electrical data etc from equipment throughout the ship. After analyzing this, it decides whether it needs to send commands to various actuators. Such actuators are machinery starters, speed controllers, breakers etc. At the same time all the information acquired is processed and displayed in the operator's consoles. The engineers on duty review this and intervene, if necessary.

Besides monitoring, it is important for an IPMS to reduce the workload of the engineers. In epopsis, there are several automatic responses to certain events. These include the starting and stopping of generators, their parallelism and load sharing according to the current power requirements.

Another task performed by IPMSs is the protection of the installation from malfunctions. The epopsis implements several emergency procedures, in order to safely handle unforeseen events, such as low pressures, high temperatures etc. These actions may selectively be disabled and alarms may be overridden, if required during battle or because of malfunctioning sensors.

All warnings must be announced without drawing any more attention than it is necessary. That is why the epopsis uses hysteresis when it signals or silences an

alarm. Also, there is an option to easily modify alarm limits, according to the condition and performance of machinery.

Finally, record keeping is another important task of IPMSs. The epopsis maintains extensive logs of all occurring events and alarms. Also, all sensor data (analog and digital) is stored and displayed graphically for extensive time periods. These are valuable tools in fault prevention and diagnosis.

## 4 Special Features

In addition to these mostly-standard features, the epopsis also implements several special ones. One of these helps engineers to sort alarms according to their severity and importance, thus allowing them to quickly prioritize their actions.

In fact, doing things quickly is a major focus point of the epopsis. For this reason, all operations are done by pressing one or two easily accessible and ergonomic membrane buttons. Pointing devices like mice, trackballs or light pens are not used because they were considered unreliable and inaccurate under heavy vibration or shock conditions.

Perhaps the largest amount of effort was placed in designing and building a system that will not fail even under harsh battle conditions. For this reason, the epopsis is comprised only of rugged industrial parts designed for marine applications. There is no mechanical wear or tear, because there are absolutely no moving parts like fans, drives etc. In order to avoid the – so common – problem of electric contact oxidation, no plugin electronic cards or components are used. Also the only relays included are solid state (SSRs) – to avoid burned contacts – and these are soldered to their sockets. Furthermore, the whole system is impervious to magnetic fields because only flash drives are used instead of regular magnetic hard drives. This way, extra data protection and system stability is achieved.

Increased stability is also achieved by running the software on embedded hardware and operating system, specially designed for critical applications. The whole architecture of the system is also a significant factor of reliability. The epopsis contains redundant units and data networks for uninterrupted operation even after

several damages. Also, the effect of damages is minimized using distributed processing.

In the unlike event of a partial or total system failure, there are plenty indicators and warning messages at multiple levels to facilitate fault diagnosis. Unit replacement can then be done quickly and easily. The epopsis is built using similar parts to achieve increased exchangeability of units, uniformity and minimal stock of spares.

Restarting the system is not expected to be required. However, even if it comes to that, there is absolutely no special procedure to shut it down and to restart it, other than hitting the power switch off and then back on. There is no data loss and it only takes 1 sec for the PLCs and about 30 sec for the operator consoles to become fully operational again.

The greatest proof of the system's durability and reliability is the fact that it has constantly been running for three years with no failures, malfunctions or crashes.

## 5 Learning Curve

It was considered very important to design the epopsis to fit exactly to the existing working methodology of the crewmembers, instead of introducing them to an unfamiliar new operating environment.

It turned out that operators learned to use the system on their own in no time while technicians were able to repair any damage with only a few hours of training.

Finally, all the displays, indicators and manuals are written in Greek, using simple and very explanatory descriptions and graphics.

## 6 Support

Since the epopsis was fully developed and constructed by the Hellenic Navy, all knowledge required for providing technical support is already available for free. Therefore, other than a very small number of spare parts, nothing else is needed in order to perform any repair, modification or future upgrade.

Even if the production of a part stops and the part itself becomes obsolete, it can easily be replaced by another one from any manufacturer, since the design can easily be modified and adapted to the new part.

# 7 Life Cycle Cost

In the past, commercial implementations of this magnitude have been purchased for about 1 mil € per ship, offering only a fraction of the above features and having – as it turned out – low quality. The epopsis, with all its advantages, costs a total of about 30,000€.

This is only the tip of the iceberg. To calculate the overall cost of an IPMS, one must also take into account the number of times a system malfunctions, the man-hours required to repair it, the parts that need replacement, the technical assistance requested from the manufacturer, the time the ship is unable to operate etc. This "hidden" cost is not negligible at all.

The epopsis has yet to break down and the ships equipped with it have been fully operational ever since it was installed. However, even when they malfunction, all technical support can be freely provided at a moment's notice. Also, all the parts are available in the local market at prices at least 10 times lower than the parts usually found in commercial IPMSs.

The fact that the epopsis repeatedly uses a very small variety of building blocks, greatly minimizes the number of spare parts required to be stocked.

Finally, if the Navy decides to use such designs in more ships (similar or not) the cost benefit can be exponential.

# 8 Future Work

The Hellenic Navy already plans to build more systems similar to the epopsis for other ships like landing ships and frigates. Other applications – like tactical systems etc – may also be considered due to their similarity with IPMSs.

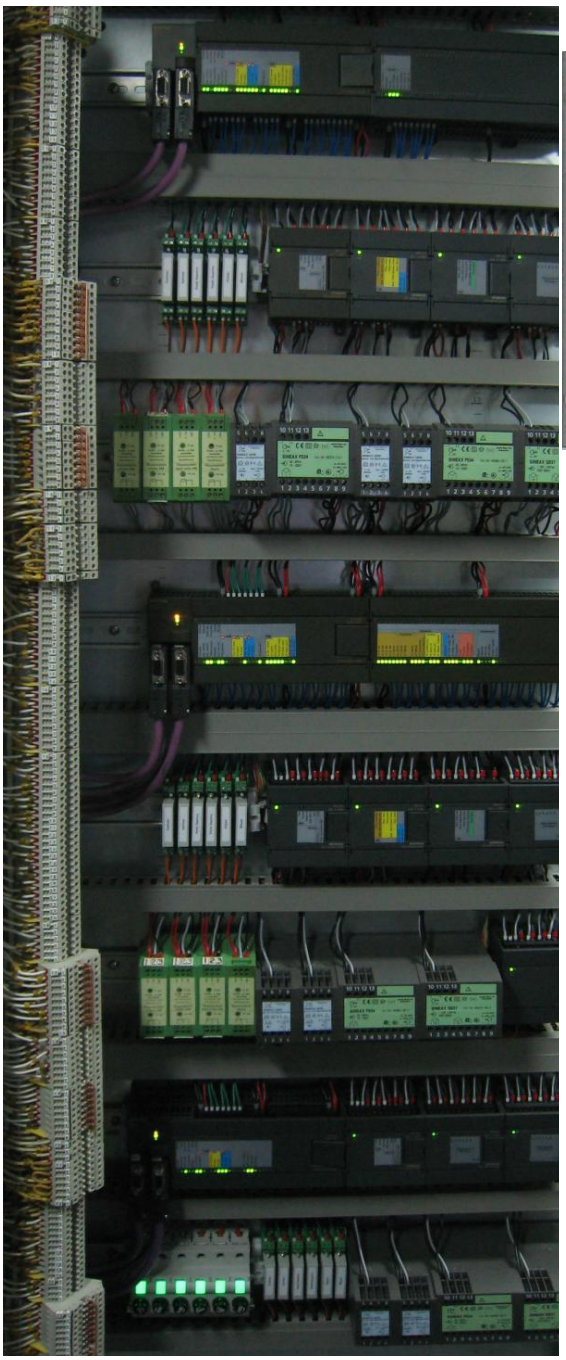

**Figure 1.** PLC Cabinet

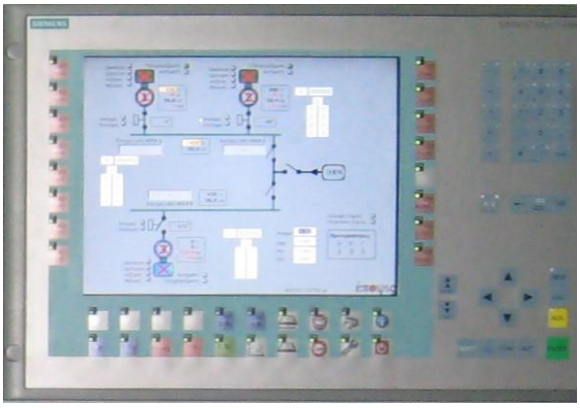

**Figure 2.** Operator's console

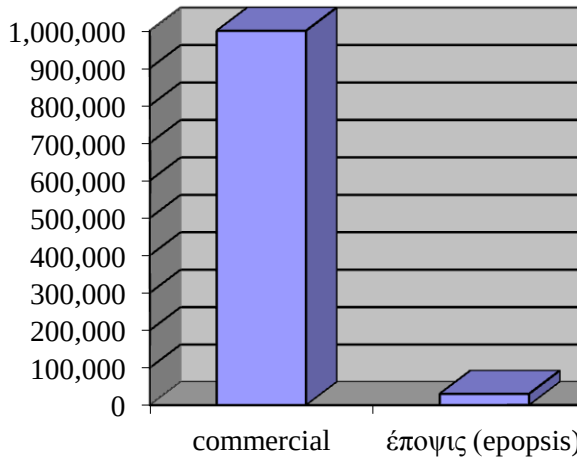


**Figure 3.** Purchase prices

# 9 Conclusions

There is no doubt that products built according to strict military specifications (mil-spec) are generally very reliable and resilient, but also extremely expensive to purchase and maintain.

As military budgets were shrinking, commercial manufacturers seized the opportunity to offer products with many features at a fraction of the previous cost. In

spite of their lower-quality, they managed to dominate the market of military applications.

This new industry bloomed and the production of electronic components and building blocks skyrocketed, at the same time driving their prices down. This now facilitates the development of custom state-of-the-art implementations by the end-users themselves. Such systems become more and more appealing due to their even lower life cycle cost and abundance of features.

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## Nomenclature

IPMS: Integrated Platform Management System

Mil-Spec: Military Specifications

SAT: Sea Acceptance Trials

PLC: Programmable Logic Controller

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