Obsolescence of Electronics at the VLT
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Introduction
The ESO Very Large Telescope Observatory (VLT) at Cerro Paranal in Chile had its first light in 1998. Most of the telescopes' electronics components are now around 20 years old. Electronic technology is advancing fast and spare parts are often no longer available on the market while new technology is evolving. This puts at risk the availability of telescope sub-systems and other operational equipment.

This poster shows the analysis, approach, timeline, complications and progress in upgrades at the Paranal Observatory.

Status Analysis
To start planning the obsolescence upgrade an analysis needs to be performed to identify the most critical systems and the priority for upgrades. All telescope systems were analyzed with respect to the following criteria:

For all systems:
1. How many critical spare parts do we have in stock?
2. How many failures has the system experienced in the last 1-2 years?

As result we can extrapolate to the future and get the estimated survival time before spare parts are exhausted.

For commercial off the shelf (COTS) systems:
1. Is the component still available on the regular market?
2. If not: is the system still available on the secondary market (used, Ebay, repaired, etc.)?

For custom built electronics:
1. Is the original supplier still able to provide spares?
2. Do we have the full knowledge, documentation, specs of the system?
3. Are we able to replicate manufacture, re-design, etc. the system?

Result of analysis: List with a ranking of priority for upgrade. If estimated survival time is <= 1 year, priority is highest (critical). See Table 1.

Upgrade Technology
Next step: Decision what technology to choose for the upgrade. This depends mostly on the original technology:

- PLC (Programmable Logic Control): upgrade to next or latest generation PLC
- Motor drives: Use latest generation drives (upgrade from analog to digital technology)
- Custom electronics, most difficult to choose:
  1. Find commercial electronics (preferred solution!)
  2. Redesign with today's technology, leading again to a custom built system.
  3. Implement the application in software where possible
- VME: new generation boards or full redesign of hardware and software compatible boards by virtualizing, using FPAGAs.
- Relay based emergency stop and interlock chains: Replace with Safety PLCs

Strategy
Having four identical telescopes has the advantage, that once the technical solution has been developed it can be tested in one telescope. Only when the new system is robust, is implemented in the remaining telescopes. Design and development effort is therefore reduced. Old parts that were removed can serve as spares for the remaining telescopes, extending the lifetime before upgrade is necessary (gaining time).

Upgrades are not aiming at improvement, but rather focus on long term availability of the telescopes. However in several cases we could improve maintainability for example by adding local touch screens.

Planning
Once the priorities are known and the upgrade technology is selected, a cost estimate is done, at least for the high priority systems. For the full planning we need also to estimate the design and implementation time line to plan and request the Technical Time slots. Table 1 shows the technical shutdown time period that is required for some of the upgrades. Technical nights have to be requested between 6-12 months in advance in order to be coordinated with the science schedule.

An approved formal change request or project request is required, before starting an upgrade project.

Having four identical telescopes allows to re-use decommissioned electronics after first upgrade as spares for the remaining telescopes. This extends the lifetime before another upgrade is needed.

Lessons Learned and Recommendations
- When upgrading systems to new technology, expect teething problems and more failures during initial period, until all problems are understood and sorted out.
- New design is first implemented in one telescope and tested for several month until robustness is proven before using it on other telescopes.
- Time needed for design and implementation were often underestimated. Main reasons: lack of as built documentation, complex reverse engineering, unexpected technical problems. In addition: Time consuming call for tender process for external contracts and occasional hardware delivery delays.

Recommendations:
- Plan upgrades as early as possible. Even during design phase of the telescope it could already be worth to consider this aspect. What initially may seem to save cost could later become very expensive.
- Use industrial off-the-shelf technology wherever possible.
- Avoid “home-made” electronics and prototypes where firmware and internal design information is not fully available to the end user.
- Avoid special products from very small companies.
- For custom built equipment procure sufficient spares as long as they are available.
- Give preference to modular design that uses standard interfaces and standard communication protocols.
- Check obsolescence policy of equipment manufacturers.
- In original design plan sufficient spare space in electrical cabinets. Later upgrades do often (surprising but true) require more space.

Conclusion
Large telescopes have a lifetime much beyond 20 years. As a consequence technology upgrades are unavoidable. This is a major effort that must not be underestimated in terms of complexity, man-power, downtime and budget.

Early analysis and planning is important to avoid surprises when it is too late. Consider the necessary budget.

Keep in mind the above mentioned recommendations can help to avoid headaches and surprises and will help to keep large telescopes operational over decades.