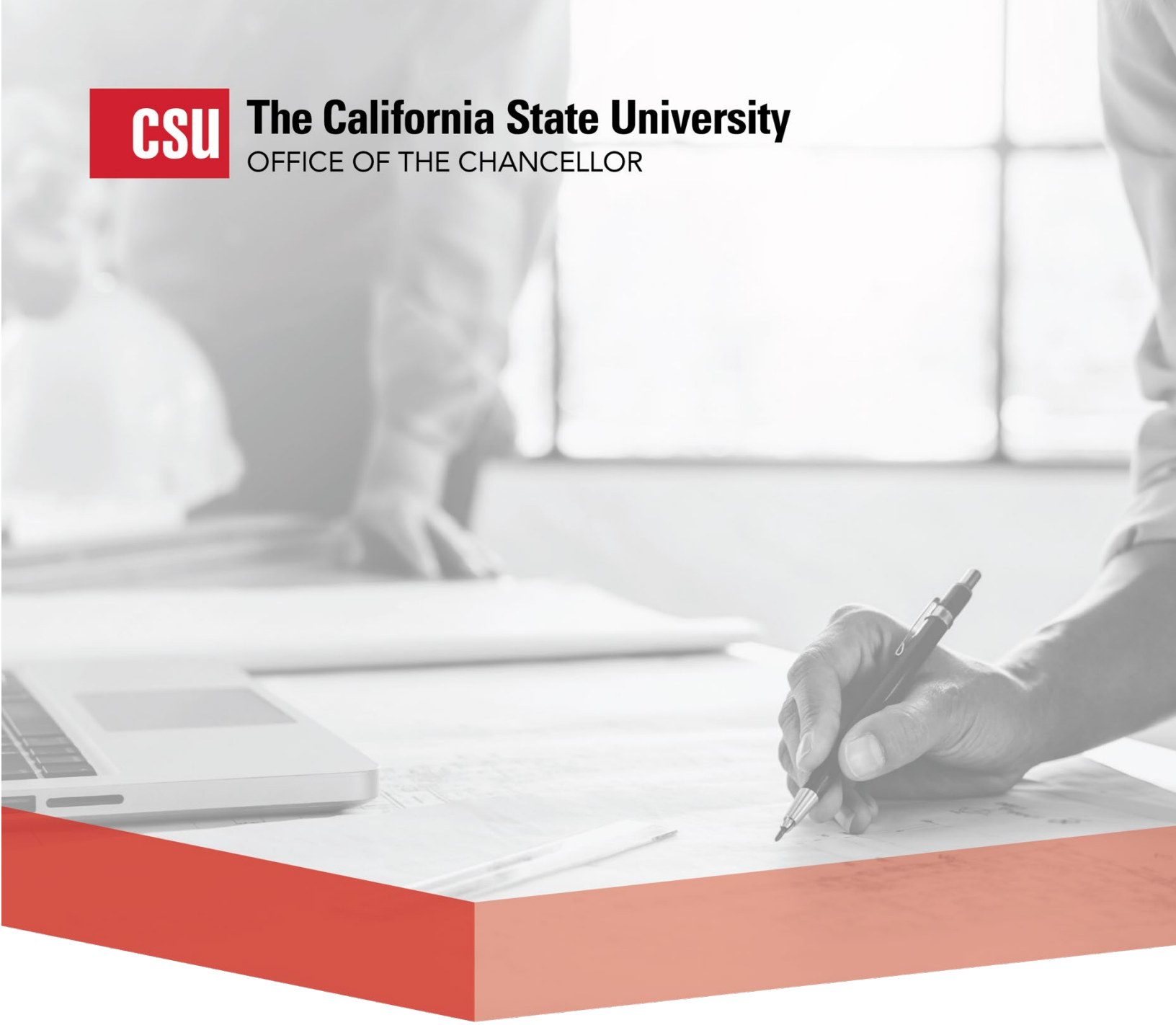

The California State University
OFFICE OF THE CHANCELLOR

Building Automation Systems Procurement Guide

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SECTION 1:
Introduction

CSU campuses currently use Building Automation Systems (BAS) to monitor and control mechanical and electrical systems such as central heating and cooling plants, HVAC air distribution systems and terminals units, etc. Most campuses find their BAS is able to meet technical energy management and control needs, but they have not been satisfied with other aspects such as competitive pricing, maintenance, and service. Few campuses have found approaches that fully meet their needs.

Ideally, the BAS should provide and maintain the following features:

a. Excellent comfort control

b. Low BAS maintenance and operator training costs

c. Minimum energy usage and energy costs

d. Extensive energy and efficiency performance metering and monitoring

e. State-of-the-art fault diagnostics and alarming capabilities

f. High density trending capability for analysis of system performance

g. Competitive first costs both for the initial phase of construction and for future phases as the campus expands

h. Competitive costs for responsive post-construction contractor maintenance and support

i. Flexibility with respect to possible changes in control system manufacturer in the future in case systems or their contractors do not perform as desired

Many systems can meet the technical goals posed by items 1 to 6. The more difficult task is developing a procurement approach that is successful at delivering features 7 to 9. The purpose of this Guide is to discuss the various procurement options that have been used and to recommend the few that have been the most successful at delivering these features.

SECTION 2:

Procurement Options

The table below summarizes the most common BAS procurement options. Most but not all options apply to both new campuses and expansions of existing BAS for existing campuses. Recommendations for both the best option for both new and existing campuses are provided in Section 5.0.

Table 1 - Procurement Options

Approach	Description	Advantages	Disadvantages
Open bidding	Allow any qualified bidder to bid each project. Results in various manufacturers being installed in different buildings across the campus.	Usually lowest first costs No legal issues	High maintenance costs. With the 7 to 12 manufacturers that may result from this approach, staff levels would have to increase several-fold over normal levels. Training requirements would increase by 100% with each new system added to campus. Poorly operating MEP systems would result due to insufficient training, familiarity Higher-end energy control strategies would be difficult or too costly to implement since data between different systems cannot easily be shared.
Two manufacturers, pre-qualified	Pre-qualify and select two manufacturers and allow only those two to compete on campus projects.	Limited competitive bid Maintaining two systems is manageable (although not as easy as one) Good option for campuses currently with unsuccessful sole-source approach	Politics and legal issues involved in picking the two manufacturers (e.g. why not three? Why these two?) Compatibility between systems required for higher-end control strategies that require inter-communication of data Cost control for expansion of existing building systems still required – may necessitate unit pricing or open book pricing Collusion among the bidders is possible over time. One manufacturer may fail to perform, leaving only one preferred manufacturer and subsequent reduced competition.

Approach	Description	Advantages	Disadvantages
Two manufacturers, low bid	Select the low bid for initial campus construction (or existing sole source manufacturer) then allow any manufacturer (perhaps limited to compatible manufacturers; see option 7) to bid new projects. The low bidder becomes the second allowed manufacturer for all future phases.	Limited competitive bid for work after initial bids Maintaining two systems is manageable (although not as easy as one) Good option for campuses currently with unsuccessful sole-source approach	No prequalification required. Still a political/legal question, "why not three manufacturers?", but the question, "why these two" is defused. Compatibility between systems required for higher-end control strategies that require inter-communication of data. This may limit acceptable second manufacturers, reducing competition. Cost control for expansion of existing building systems still required – may necessitate unit pricing or open book pricing Collusion among the bidders is possible over time. One manufacturer may fail to perform, leaving only one preferred manufacturer and subsequent reduced competition.
Sole source with equipment price controls	Select initial manufacturer based on low bid for initial campus construction (or existing sole source manufacturer) then allow only this manufacturer for all future projects with price controls on equipment (e.g. GSA pricing) to ensure competitive equipment pricing. Pricing from manufacturer should be obtained prior to bid and stipulated in bid documents.	Only one system reduces training and maintenance costs	Parts from manufacturer amount to only about 15% of total costs. Total parts and equipment costs amount to only 30% to 50% of project costs. This approach does not ensure competitive pricing on application engineering, installation, and start-up and commissioning. A labor rate for these tasks is a good idea but not enough to limit these costs. Danger of "low balling" initial bid with higher pricing for future phases.

Approach	Description	Advantages	Disadvantages
Sole source manufacturer supplying only "parts and smarts"	Select initial manufacturer based on low bid for initial campus construction (or existing sole source manufacturer) then allow only this manufacturer for all future projects to provide only application engineering, parts, final terminations, and start-up and commissioning. Manufacturer would prepare drawings for all sensor and control wiring prior to bid. Conduit/wire and installation and sensor installation to be included in Division 23 or 26 as part of bid. Price controls on equipment (e.g. GSA pricing) and labor rates. Pricing from manufacturer should be obtained prior to bid and stipulated in bid documents.	Only one system reduces training and maintenance costs Competitive bid on wiring and conduit and sensor installation	Does not ensure competitive pricing on application engineering, start-up and commissioning, which amount to about 15% to 35% of project costs. A labor rate for these tasks is a good idea but not enough to limit these costs. Danger of "low balling" initial bid with higher pricing for future phases.
Sole source with unit pricing	Select initial manufacturer based on low bid for initial campus construction (or existing sole source manufacturer) but also include unit pricing of typical applications, including costs for installation, engineering, and start-up and commissioning. Unit prices for future projects must be weighted so that low bid includes impact of future phases. Unit prices are regularly renegotiated and adjusted for inflation, etc.	Only one system reduces training and maintenance costs Future buildings fairly priced as long as unit price systems cover a large majority of building applications.	High engineering cost required to define unit pricing items and their scope. Added bid effort may dissuade some contractors from bidding. Not all applications covered by unit pricing, possibly resulting in some price inflation on unusual applications. Prices will have to be updated after a few years to reflect inflation and technology changes, leaving open the possibility of future price inflation due to no competition.

Approach	Description	Advantages	Disadvantages
Open protocol systems	Limit bidding to systems using one of the two open protocols (BACnet or LonWorks). Select protocol based on low bid for initial campus construction (or existing sole source manufacturer provided they use open protocol) then allow only manufacturers using this protocol for all future projects.	Low cost due to multiple bidders, although number of bidders is reduced after initial installation in order to ensure compatibility. Ensures that gateways to subsystems (e.g. chillers, lighting) will remain supported (unlike those to proprietary networks)	Eliminates manufacturers with proprietary networks, although few remain at this time anyway True plug & play ideal is not currently possible with either protocol. Gateways are generally required just like to proprietary networks. Does not eliminate the need to learn and use multiple set-up and application engineering programs for each manufacturer. Greater networking knowledge is required to successfully integrate multiple open protocol systems at a single location, particularly with LonWorks No single source of responsibility for inter-compatibility
Manufacturer represented by multiple installing contractors	Limit bidding to control systems that are sold "over the counter" to various installing contractors, or to systems that have multiple contractors/dealers serving the same geographic territory, allowing the contractors to compete but limiting the controls hardware to a single manufacturer. Price controls on equipment (e.g. GSA pricing) to ensure competitive manufacturer equipment pricing.	Only one system reduces training and maintenance costs Low cost due to multiple bidders, although number of bidders may be limited Flexibility in future for service and installation; if one contractor does not support the product well, others are available	Can limit manufacturers since only a few manufacturers have multiple contractors/dealers serving one territory Because of the remoteness of some campuses, there may not be many contractors representing these products, reducing, perhaps eliminating competition For "over the counter" products, quality of installing contractors varies since generally "anyone" can sell the product No single source of responsibility for inter-compatibility due to numerous installing contractors

Approach	Description	Advantages	Disadvantages
Multiple manufacturers with third-party integrator	Allow multiple manufacturers to bid each building (perhaps limited to open protocols) but use a common “single seat” front-end graphical user interface that can provide the same look-and-feel interface to all systems	Low cost due to multiple bidders	Limited third-party integrators on market Integrator generally becomes sole source after first phase of construction Requires cooperation among various manufacturers and contractors No single source of responsibility for inter-compatibility due to numerous installing contractors Does not eliminate the need to learn and use multiple set-up and application engineering programs for each manufacturer. Higher-end energy control strategies would probably not be possible since data between different systems cannot easily be shared and front-end system mostly likely will not have the speed to serve as a gateway for transfer of data required for control loops.

Approach	Description	Advantages	Disadvantages
Campus becomes dealer and installer	Manufacturers pre-qualified to those that would allow campus to become a dealer. The controls would be bid among qualified manufacturers for the initial construction, then the campus would become a dealer of the selected system and self-perform controls design, start-up, and commissioning on all but very large projects. Conduit, wire, and sensor installation would be bid as part of Division 23 and 26 work.	Only one system reduces training and maintenance costs Lower installation cost since no mark-up and profit from outside firm In-house personnel are experts (not just trained) on system and thus can maintain it better, improving energy and comfort performance Small changes such as adding a zone or optimizing control programming can be more easily done (no outside POs and contracts to write)	Limits manufacturers in initial bid to those willing to allow campus to become a dealer. Exposure to inflated pricing on large projects since local non-campus manufacturer will be required (in-house staff will be most likely be too small) Requires commitment from campus to hire and retain high-end controls technicians and a department manager. If this does not happen, this option in effect becomes the sole-source approach. Overhead higher due to larger number of and management for in-house technicians. If managed well, however, this cost will be offset by reduced control system cost. If the in-house group does not perform on a project, they can be blamed for any delays or problems that arise, resulting in claims against campus. Lack of continuity if controls work is not continuous since not enough work to keep technicians employed Difficulty in accounting for in-house costs used for construction projects

SECTION 3:

Interoperability and Open Protocols

Open protocols are those whose characteristics are published and may be used by anyone freely or by license. There are two major open protocol systems used in building BAS: BACnet and LonWorks.

The BACnet protocol was developed using the ANSI consensus process through ASHRAE. BACnet was designed for building automation systems by BAS manufacturers and users and is under continuous development by ASHRAE and worldwide user groups.

LonWorks and the LonTalk protocol were developed by a manufacturer (Echelon) through a private process and must be licensed. It is supported by an organization of manufacturers (the LonMark Consortium) who develop implementation standards and device certification. It was developed as a general information network protocol and has been applied to many industries in addition to building control.

The goal of open protocols is to provide interoperability among multiple manufacturers, much the way Microsoft Windows-based PC peripherals from various manufactures can be installed and operated with minimal user configuration. Unfortunately, this "plug & play" ideal is not currently possible with either BACnet or LonWorks. Furthermore, even when different devices are able to coexist on a single network, each product will still have its own proprietary setup and application engineering software, and each will have its own unique maintenance requirements for which operators must be trained. Thus, from a maintenance and operations standpoint, there is no advantage, and in fact there may be a distinct disadvantage, to mixing BAS controllers from various manufacturers even if they were interoperable.

If a single BAS manufacturer is used for the entire campus (some type of sole-source relationship), interoperability would seemingly not be an issue – the BAS clearly could use either open or proprietary protocols.

So why consider limiting BAS manufacturers to only those using open protocols? The primary advantage for a CSU campus is that it provides an "exit strategy;" it makes it much easier and less disruptive to migrate to another manufacturer or product line in the future. There are a number of plausible scenarios that could trigger this need, including: insolvency of the manufacturer, problems with either the supplier or local support, or acquisition of the manufacturer by another control company that discontinues support of legacy systems. In any of these cases, new projects could be completed with a new manufacturer/product line using the same open protocol while the existing systems are phased out over time. With an open protocol system, a single interface and, possibly, a common network could be used to access all of the controls throughout the transition period.

Another advantage of an open protocol is that third party software for user interface, trending, and alarming can be employed across all of the manufacturers' systems. Open protocols also make it easier and less expensive to maintain gateways between the BAS and subsystems (e.g. lighting and chiller controllers) as software on either side of the gateway is updated with new versions. (Proprietary BAS protocols can require expensive custom reprogramming of gateways when software upgrades are made.)

Finally, companies that use open protocols tend to have a different overall business relationship with their users, a less "possessive" attitude; they earn future business by meeting customer needs, not by trapping customers with proprietary products.

Limiting manufacturers to those using open protocols no longer limits competition in any significant way since one of the two open protocols are available from all BAS manufacturers. So, except for legacy systems, proprietary protocols should not be allowed. Of these two common open protocols, BACnet is by far the most widely used for building automation and available from all major BAS manufacturers. Only a few manufacturers still have LonWorks lines. If the campus does not already have a legacy LonWorks product line and infrastructure, BACnet is recommended.

SECTION 4:

Integration with Security and Fire Alarm Systems

It is possible to integrate the BAS with other systems such as security, fire alarm, and life safety systems into a single system sharing a common network and controllers. This allows them to share points and information, such as:

- For buildings requiring smoke control (e.g. high-rise buildings or atria), control points such as fan status and damper overrides can be shared between BAS and fire/life safety controls, reducing sensor costs.
- Security data can be used for BAS logic, such as starting HVAC systems or enabling lighting when a space is entered during off-hours using a security card-key.

But there are several disadvantages to device level integration:

- It limits the number of manufacturers since very few offer fully integrated systems. To use the BAS for smoke control, the product must be UUKL listed, further limiting product options and possibly increasing controller costs. The reduced competition can (and usually does) offset the cost savings noted above resulting in increased overall costs.
- Fire/life safety systems must be fully tested and approved by local fire authorities before the building can be certified for occupied. BAS is notorious for being late in completion – they are seldom fully commissioned and operational when the building opens. Integrating the two can therefore jeopardize occupying the building on time.
- Integrated systems are more prone to failure of critical components due to improper work done on less critical elements. For instance, with an integrated BAS and security system it is possible for an HVAC maintenance worker to inadvertently bring down the security system network during routine BAS work.
- Integrated systems are more prone to "hacking" and unauthorized penetration of security systems. Insurance carriers often restrict integration for this reason.
- Security, life safety, and energy management/maintenance are generally assigned to different departments on campus so there is little opportunity for labor savings (and more opportunity for unauthorized access) due to integration.

Generally, the disadvantages of integrated systems far outweigh the advantages. The one advantage of integration, sharing information, can be easily (and usually less expensively) be accomplished by connecting the systems using I/P level BACnet gateways or hard-wired I/O points.

SECTION 5:

Integration with Lighting Control Systems

BAS from the 1990s and early 2000s often included relay panels to control lighting, usually on a simple time schedule. Over time, occupancy sensors and daylighting controls were developed, generally spurred by Title 24 Energy Standards. Initial versions of these devices were hardwired local controllers, not readily integrated with the BAS. But modern lighting controls have progressed to network-based systems with "smart" addressable control devices. Unfortunately, the lighting control industry developed independently from the HVAC BAS industry, so lighting controls are specified by different engineers (electrical vs. mechanical), usually use different network protocols, are manufactured by different manufacturers, and are installed by different contractors (Division 26 vs. Division 23). While there is potential synergy to having HVAC and lighting controls share the same network and front-end interfaces, the current market is fractured so this is not yet practical. Despite having independent systems, sharing information is still possible using I/P level BACnet gateways which are available from all major lighting control manufacturers. The most commonly shared information is occupancy sensor status from the lighting controls, which can be used for resetting temperature and ventilation setpoints when spaces are unoccupied. Time schedule sharing is also possible but usually requires significant programming effort.

SECTION 5:

Procurement Recommendations

Based on interviews with UC and CSU campus engineering and energy managers, the ideal BAS procurement approach will:

- Result in a single BAS manufacturer for ease of maintenance and integration of all campus buildings.
- Provide cost control through long term competitive pricing as the campus expands.

The best approach to achieve these goals depends significantly on the status quo at the campus. **Table 2** summarizes typical campus status quo and recommended approaches for each. However, these are guidelines only; conditions at each campus and the campus' relationship with current manufacturers and dealers/contractors can change the desired procurement approach.

Table 2 - Procurement Recommendations

Current Campus BAS Status Quo	Recommended Approach	
	No. (See Table 1)	Description
New Campus or BAS	7+8	Limit manufacturers to "native" BACnet open protocol and to those that have multiple dealers willing to share the CSU territory. (May not be possible at all campuses.)
Existing sole-source manufacturer, satisfactory relationship	5+7	Sole source manufacturer should supply only "parts and smarts," allowing conduit/wire and installation and sensor installation to be included in Division 15 and 16 as part of project bid. Price controls on manufacturer equipment (e.g. GSA pricing), purchased equipment (purchase price plus fixed markup), and labor rates. Manufacturer should be required to migrate to open protocol option if currently proprietary.
Existing sole-source manufacturer, unsatisfactory relationship	7+8 or 3+7	If other dealers of manufacturer product exist locally, insist that they be allowed to bid as well. or Open bidding to a second manufacturer that uses same protocol as existing manufacturer.
Existing multiple manufacturers	3+7	Migrate toward only two manufacturers that use the same open protocol, preferably "native" BACnet.