Utility Information System

Backgrounder

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INTRODUCTION

The Utility Information System (UIS) is a software product which analyses utility usage data and costs and provides sub-billing services. It was developed in 1997 for the University of Sydney, having multiple campuses, a large number of buildings and significant annual usage costs.

The solution, written in Powerbuilder and involves extensive integration through a Sybase database. Consumption and cost information is taken from file imports, data entry and continuous meter reading software and processed in three stages for analysis via Excel, reporting via the Internet and sub-billing via Peoplesoft Financials. The result is a comprehensive, integrated, flexible and user-friendly software system.

Fully operational for five years, UIS allows the university to:

1. Import electronic data from suppliers and university-owned metering devices.

2. Record monthly water, electricity and gas consumption, accurately via data entry in a user-friendly manner.

3. Access via the Internet, consumption and cost data over a three year period in a graphical and tabular format.

4. Create spreadsheets with dynamic access to stored consumption and cost data.

5. Generate summary or other derived data using complex consumption formulae.

6. Allow managers to perform data simulations and "what-if" scenarios of their own design using the spreadsheet.

7. Provide a single journal and internet statement for each department and other institution which covers water, electricity and gas consumption and costs, eliminating paperwork and reconciliation effort.

This backgrounder is designed to introduce the UIS from a variety of organisational and functional perspectives.

Further information is available on the UIS website http://www.usyd.edu.au/is/uis

1. PARTIES

The University of Sydney

The University of Sydney was established in 1850, with a rich diversity of courses and a reputation for teaching and research excellence. The University has enrols almost 40,000 students annually and employs almost 6,000 staff.

Facilities Management Office (FMO)

The central campus of the University of Sydney is situated south-west of the Sydney CBD, and contains a mix of heritage and modern buildings. FMO is responsible for this infrastructure and for other campuses across Sydney and New South Wales.

FMO is divided into four operational groups. An important function of the Project Services Group is the provision, maintenance and monitoring of utility services - principally water, electricity and gas. These functions are delegated to the Energy Officer, Mr. Grahame Pepper.

FMO was responsible for commissioning UIS and operates it in the pursuit of these operational and strategic aims.

Information Technology Services (ITS)

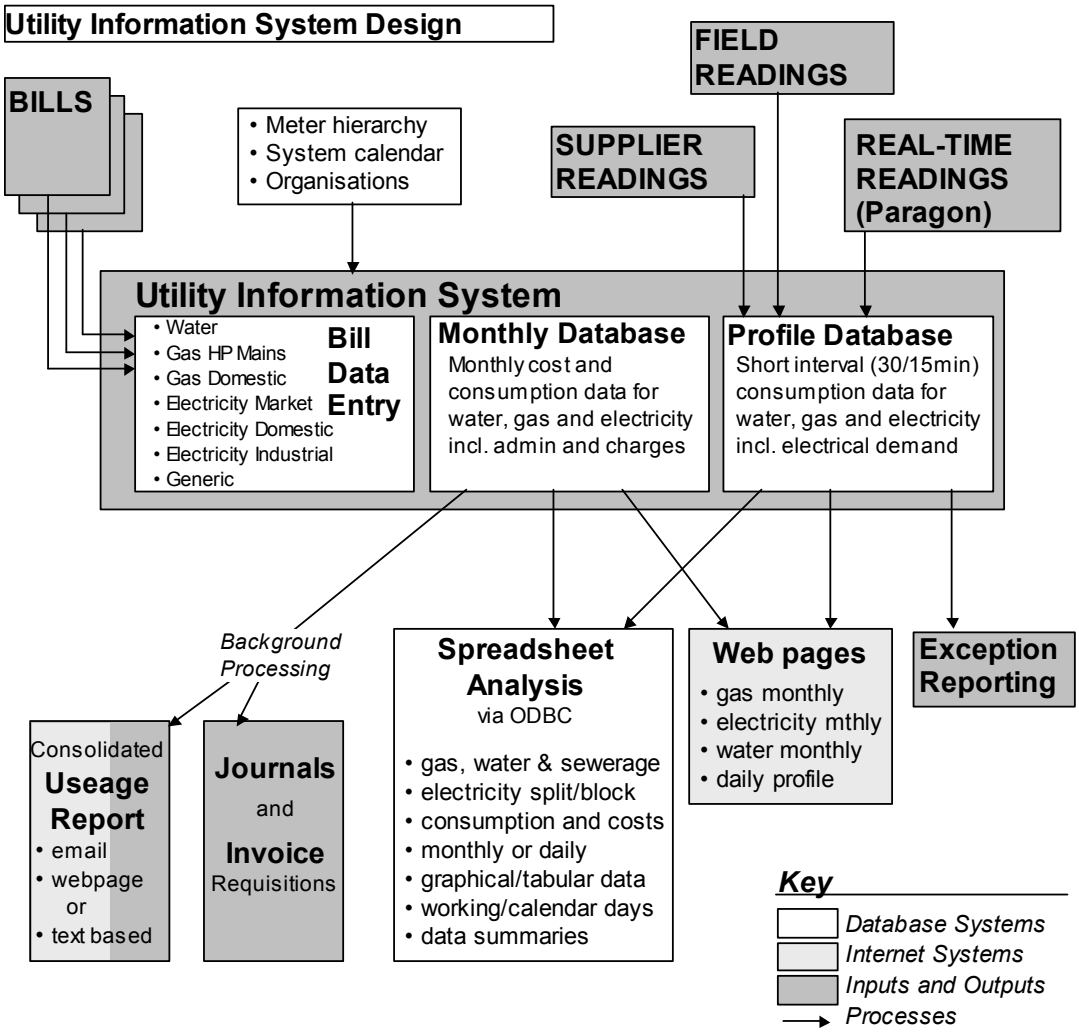
ITS is responsible for the development and maintenance of the principal administrative computing systems of the university. It has a secondary role-providing contract computing services for administrative and academic departments.

ITS was internally-contracted to develop the UIS system in 1997. It employed Mr. David Latimer and other contractors to complete the work.

2. FUNCTIONAL OVERVIEW

UIS is designed to collect up all the information from the various metering and billing systems and to do so with minimum human supervision. At the business end, the system supports all the utility and energy objectives defined by the management strategy.

As shown in the schematic below, it outputs financial and analytical data via a database/spreadsheet hybrid. Sub-billing is completed electronically and any staff member of the university can view the same output on the web in both graphical and tabular form.



UIS addresses six principal objectives which cover key information technology aspects of water and energy management. These are as follows:

1. Usage Control

The management of consumption and demand, especially to preventing cost blowouts requires the analysis of real time and historical information. Accurate and focused information can target operational problems whether it be due to equipment malfunction, installation of new equipment or operational efficiencies. The data is also a catalyst to facilitate continuous improvement in operational functions and in water and energy conservation across all campuses.

UIS collects and processes consumption and demand data at the earliest possible instant. Where smart meters are connected on-line, action can be prompted within minutes of an incident.

2. Billing/Sub-billing System

UIS integrates and automates the financial processes related to utility management.

UIS collects, through data entry, the bills of all suppliers, be they for water, electricity or gas. This is necessary to meet procurement objectives, but it has been instrumental in identifying errors in supplier bills. Although the data entry operator is presented with the simplest possible user interface, they are alerted to potential errors after every save. Warning over-rides are recorded so the Utility Manager may monitor data entry operations.

A significant percentage of the university's water, electricity and gas is used by residences, student bodies and others who are charged through the finance system. UIS allowed the university to fully automate this sub-billing process.

The automation is so complete, the system can determine not just the cost but also the consumption and derived unit rate. Even minor price fluctuations are fairly carried through to sub-bills in accordance with the relevant authority regulations.

Bills are integrated, firstly in the sense that water, electricity and gas are detailed together on one monthly or quarterly bill. In the second sense, the system integrates data from suppliers, smart meters and interpolated values. The delivery of usage reports over the Internet completes the automation.

3. Maintenance Management Tool

The system provides for the analysis of information and establishment of benchmarks for maintenance needs. These range from tracking actual usage against benchmarks to close tracking of problematic or high-risk plant.
Early warning of variances from historical or expected norms can not only save direct usage costs and but forestall functional problems, extend the life of plant and equipment and even improve the operational environment for staff.

The across the board interest, from suppliers to maintenance staff and to users, is of great value in finding a co-operative approach to solving problems. The relatively aged and inefficient buildings of the University of Sydney makes this ability to quickly identify variances, very desirable. UIS generates this interest through the range its management reports covering the most general or specific detail. In the alternative, these could involve

quite complex calculations, however UIS automatically interpolates data from a variety of sources.

Also of interest here, is the daily exception report which tests the previous day's data against historical patterns. This gives the Utility Manager a starting point in identifying operational maintenance incidents.

4. Strategic Planning

The information gained on both engineering systems and more comprehensive building solutions needs to be continually built upon whilst allowing succinct trend and performance data to be extracted. This is essential not simply for general management but also to identify if keystone projects are in-fact viable and will perform to design.

Modelling and monitoring of strategic initiatives is essential. The accuracy and reliability of the UIS database teamed with adaptable spreadsheet tools provides limitless capacity to investigate, say, the gravity of an environmental concern or the potential of power-factor correction.

Benchmarking moves from theory to practice. The practical difficulties in finding the right methodology range from the varying function, age and size of university buildings to the dynamic populations in and out of the semesters. UIS can factor-in these realities.

5. Engaging Users in Savings Programs

UIS provides for opportunities in heightening user awareness and involvement in water and energy savings programs by providing clear and informative advice and an invitation to participate. This requires timely and easily assimilated information which can be distributed with billing information and web based "near real-time" information.

The quality of the information its presentation is very engaging, hard to deny and usually generates a positive response. People who have their interest stimulated are less likely to feel confronted and more likely to co-operate in proposed solutions – an important consideration in a non-user pays environment.

7. Deregulation

In a deregulated market, UIS provides quality information for informed procurement with consequent cost savings. All historical procurement information, including ancillary services and costs is recorded and a schematic model of the physical utilities network interpolated with actual consumption, demand and expenditure provides a complete description of the flow of water, electricity and gas across all campuses and properties of the university.

With this information, UIS can interpret current trends and project these into the future, while taking into consideration historical cycles. From its relational database, UIS extracts the relevant summary or cross-section to Microsoft Excel for graphical presentation and extended analysis. These are used to investigate the cost-benefit-penalty relationship of proposed contracts.

3. MAIN FEATURES

With UIS, the list of features is quite extensive. Some features are indispensable, others are highly technical, but all are useful. In this section some novel but important features of the system are discussed in-depth. These and other innovations will add years to the life of any conscientious Utility Manager. They will gain the days and weeks needed to commence their savings programs and squeeze their procurement contracts.

Encapsulated Intelligence

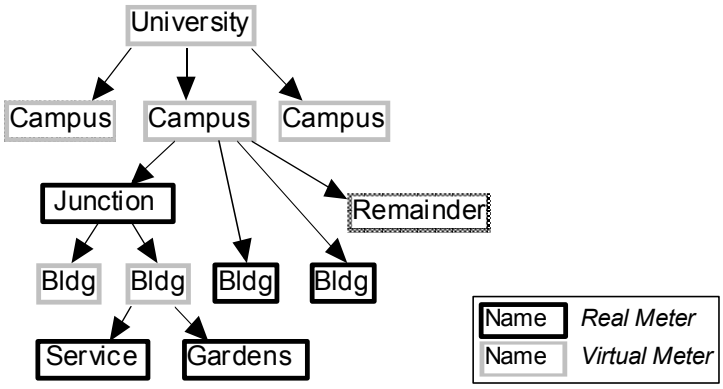
From a computing perspective, the greatest achievement of the development team was the "intelligence" built into the software. This in-built intelligence provides capabilities far beyond any potential alternatives. These include:

- **Data linking.** An intelligent computer system should be more than the sum of its parts, so this system links data from different sources, with different frequencies and across its network schematic. For example, a buildings water costs will depend upon the campus water rates.

  Most alternatives allow the manual formulation of such links, but for a university network this is impossibly complex. Consequently, UIS intelligence was designed to bypass this daunting task.

- **Network calculations**. A complete schematic of the electricity, gas and hydraulic networks is modeled within the software. When "virtual meters" are inserted into the network, the system can interpolate consumption and costs based upon real meters in its neighbourhood. This would be extremely complex, especially with co-incidental maximum demand values, but its rendered intuitively simple.

  Below: Virtual meters are inserted into a network schematic. They don't really exist, but are based upon neighbouring real meters.



- **Interim values.** A computer system can only be as responsive as its data inputs, so what happens when the data for the last day of a monthly calculation is due in next quarter's bill?

  Most computer systems would simply stop right there. UIS intelligence however generates an interim result, which can be used in any report except sub-billing. When the missing data is found, the interim result is updated with a final result.

- **Data-driven processing** refers to the underlying processes which allow UIS to process megabytes of data every day. They "know" exactly what to process, what to reprocess and what to leave alone.

The results are seen in faster and more effective training plus simpler configuration procedures. Fundamental errors are dramatically reduced and the system can respond quicker to changing circumstances.

Database/spreadsheet hybrid

Aware that many Utility Managers make use of this spreadsheet technology, UIS makes good use of a spreadsheet/database hybrid – that is, a spreadsheet with a database (SQL/ODBC) connection.

Each of the newly designed spreadsheets collects a small segment or a summary of the whole database – data that would otherwise need to be retyped. Graphs, statistical formulae and summations are then inserted. Any number of spreadsheets may be constructed without risk to the original data. It is also prudent to run the same graphs and formulae with different data selection criteria, for example a different building or different year.

The hybrids make it easy to create modified versions of an existing spreadsheet. For instance, a growth chart rather than a consumption chart. The basic data is the same, however the spreadsheet formulae are altered. Note that once altered, a modified spreadsheet will continue to work with different data selection criteria.

Water and Energy On the Web

Most staff and students of the university are active users of the Internet and there exists no better way of sending the Utility Managers message of conservation and economisation.

The successful promotion of utility saving within the university community is dependent upon staff and students alike understanding and responding to the environmental and financial impact associated with their building's utility usage. Their expectation is the availability of on-line, high quality utility information which is now readily available from the Utility Information System.

On passing a standard but effective security check any authorised person can review, with respect to any building or meter on campus:

- consumption profile over previous three or sixteen days
- total monthly consumption over previous three years
- total monthly costs over previous three years
- electricty on-peak, shoulder and off-peak consumption and costs

Information is presented in both full colour graphic and tabular numeric forms.

The website, used in conjunction with general conservation advice, is used by staff members with an ecological conscience, maintenance staff checking the operation of major plant and engineering students studying efficiency of building design and equipment.

4. HISTORY

Original Project Proposal

The need for an integrated application was identified by Mr. Grahame Pepper and in October 1997, he commissioned Mr. David Latimer of Information Technology Services (Dept) to determine the requirements of an integrated system using database technology.

In November 1997, ITS employed Mr. David Latimer to develop a full proposal to submit to FMO. This proposal was accepted and approved in December by Professor Ken Eltis, Deputy Vice-Chancellor (Planning and Resources.)

Billing/Foundations - Phase One Development

Phase One was submitted for user testing in September 1998, however months passed before a stable version emerged. The phase was implemented in production in July 1999, with all significant issues resolved by March 2000. The objectives met by this phase were to:

1. Record monthly water, gas and electricity consumption, accurately and effectively from hardcopy bills and manual meter readings via a data entry application whose format is similar to the hardcopy format

2. Create a Sybase database to store the consumption and cost information, as collected, over any significant period

3. Calculate derivations of consumption and cost information

4. Provide spreadsheets with dynamic access to consumption and cost data.

5. Provide a single statement and invoice/journal for each department and other institution, which covers water, gas and electricity consumption and costs, reducing paperwork and reconciliation effort.

Profiles - Phase Two Development

Phase Two was commenced in July 1999 and submitted for user testing in March 2000. This phase was implemented in production in June. The objectives met by this phase were to:

1. Record short-interval (5 to 60 minute) consumption and demand accurately and effectively from meter readers via existing laptop, Paragon real-time electronic monitoring, CSV files and other file formats.

2. Extend the Sybase database to record the consumption and demand information for water, electricity and gas on a continual basis.

3. Extend capacity of spreadsheets by introducing dynamic access to short-interval consumption and demand information, including daily profile graphs.

4. Database program to complete exception analysis of short-interval information

5. Extend capacity of billing system to be able to incorporate short-interval data summaries and use for long-term analysis and sub-billing.

Internet - Phase Three Development

Phase Three work was completed in November and December 1999. The objective met by this phase was to provide a view of consumption and billing information in graphical and tabular format to university staff over the Internet.

Better Analysis - Phase Four Development

Phase Four was commenced in October 2002 and at the time of writing is in-progress. The anticipated completion is in July 2003. The objectives to be met by this phase are:

1. To automate detection of changes in water and energy consumption
2. To record climate information and incorporate into the analysis framework
3. To improve the performance of automated background tasks
4. To replace the file import system, utilising the descriptor file system developed for the Communications Accounting System
5. To introduce building profiles, including precincts, building types and multiple definitions of floor areas, which are incorporated into the analysis framework
6. To record deregulated bills using multiple time splits and other changes in response the evolving deregulated market
7. To update the Internet site to make it more versatile, user-friendly and secure
8. To develop tools to analyse the environmental footprint of the university.

Phase Four also includes a number of minor changes and cosmetic improvements proposed on the basis of four years practical experience of using UIS.

5. ASSETS / DELIVERABLES

In the course of development and extension, the UIS system consists of the following deliverables representing existing assets for exploitation or further development:

Applications and Systems

1. UIS Main Application including meter hierarchy, billing data entry forms, profile import system, financial reporting, calendar, organisational details and maintenance data. Written in Powerbuilder for Microsoft Windows.
2. Ganttry Importing System to allow the automatic import of electronic bills, profile data and weather information.
3. Sybase Stored Procedures, used to perform background tasks. These perform the monthly calculation, form calculation and exception report.
4. Dynamic Web Page written in Perl script and using Java applets.
5. Install-shield installation program

Spreadsheets written in VBA-Excel

6. UIS Monthly Spreadsheet including meter 36-month graphical sheet, all-meter yearly tabular sheet and billings sheet
7. UIS Profile Spreadsheet for profile analysis
8. UIS Campus Spreadsheet for benchmarking
9. Collating Tool for profile import. In Phase 4 this will be replaced with the descriptor file system for profile import.
10. Monthly Progress spreadsheet (an ad-hoc tool)
11. Profile Import Progress spreadsheet (an ad-hoc tool)

Main Documentation

12. Project planning and ongoing management reports
13. High-level specification (a client/developer reference showing all application objectives, functions and where possible screen mock ups)
14. Database design
15. Low-level specification (a programmer reference showing all application functionality including objects, classes, methods, database queries, screens, reports, automated procedures and spreadsheets)
16. Test plan (for user testing) including sample test data
17. Implementation plan (for handover and installation)
18. User Manual at 50% complete stage.
19. Issue and Problem documentation.

6. TECHNICAL SPECIFICATIONS

Minimum Requirements	
Operating System	Windows 2000, Windows NT or Windows 98
Hardware Requirements	
Client or Network Hard Disk:	40 Megabytes
Client RAM:	8 Megabytes (above Operating System)
Database Requirements	
Database Server:	Sybase Server 11 or 12
Database Server Size (min):	200 Megabytes
Client Drivers:	Sybase Open Client ODBD Client
Application Requirements	Microsoft Excel 97 Internet Explorer or Netscape v 3.0
Internet Server Requirements (optional)	v32 modem HTTP Server with Perl scripting enabled

Application Specifics	
Current version: Last Release date:	v1.2 24 February 2001
Internationalisation:	Only supports Australian dates and symbols
Calculation Methods:	10 profile calculation methods 6 supplier billing methods 2 virtual methods (summary and remainder)
Account code support:	20 characters (excluding spacing) 6 accounts per organisational unit
Selected database record maximums	
Max number of organisations:	32,000
Max number of meters/buildings:	32,000
Max number of bills:	20,000,000 (assuming average of 10 lines per bill)
Max num. of time of use definitions	36
Utility data types stored	Water Consumption and Costs Water Service Charge Sewerage Consumption and Costs Sewerage Service Charges Trade Waste Service Charges Wastesafe Service Charges Stormwater Service Charges Gas Consumption and Costs Gas Market Charges Gas Maximum Hour Standard Volume Gas Maximum Daily Standard Quantity Electricity Split Consumption and Costs Domestic Electricity Consumption and Costs Block Electricity Consumption and Costs Electricity Deregulated Market Charges
Utility Companies Supported:	“Generic” Company Energy Australia Integral Energy AGL Sydney Water