Collaborative software as a driver for vertical integration of objectives, processes and people

the international water association

D. Vitorino*, S.T. Coelho**

* Addition. Rua Borges Carneiro, 34 R/c, 1200-619 Lisbon, Portugal
** LNEC - National Civil Eng. Lab. Av. Brasil, 101, 1700-066 Lisbon, Portugal

Abstract: Water utilities have exponentially increased the usage of software and data solutions in recent years, from daily operation to long-term planning and corporate management. The cumulative refinement of generic software approaches has led to major advances, but marginal improvements are shrinking, as the limiting factors imposed by legacy software paradigms take over. This poster describes a collaborative and pluggable software platform and project, hosting an open range of apps focused on specific reengineering of core water utility engineering processes. Software development is combined with a long-term R&D roll-out strategy, connecting with the industry and a network of public research organizations. With references to practical workflows in water utilities, the text illustrates the increased efficiency of this new software paradigm, resulting in measurable alignment of operational, tactical and strategic objectives, processes and users.

baseform.org

Flow monitoring

Monitor
Control of non-revenue water is a chief concern of utilities worldwide. Based on reliable statistical methods and advanced technology solutions, Monitor profiles each of your metering zones' consumption patterns. Continuous analysis of water metering data, leads to automatic detection of abnormal events such as leaks, pipe breaks or meter malfunctions.

AM planning tools

PLAN: Compare & decide
A decision-support environment where planning alternatives or competing projects are measured up, compared and prioritized through objectives-guided metrics.

Performance Indicators
A tool for selection and calculation of kPI based on organized libraries, including industry standards (IWA) and user-developed libraries.

Financial project
Assess the net present value (NPV) and the investment return rate (IRR) of any financial project from a long-term/ asset lifecycle perspective.

Spatial and water system tools

EPANet Network Modelling
An efficient, Java-implemented Epanet simulation engine for full-range hydraulic and water quality network simulation, with advanced 2D/3D visualization and Google Earth integration.

SHAPE: Baseform GIS
Enables the inclusion of geo-referenced data in the analysis environment, with mapping facilities to help contextualize analysis results.

Asset system analytics & prediction tools

Failure analysis
Using system component failure records, such as work orders, predict present and future probability of failure of pipes or sewers.

Component Importance
Simulate the failure of each individual pipe in a water supply network to measure its hydraulic impact on nodal consumption.

Unmet demand
Quantify water supply service interruption risk through the expected reduced service, calculated as the volume of unmet demand over a given period.

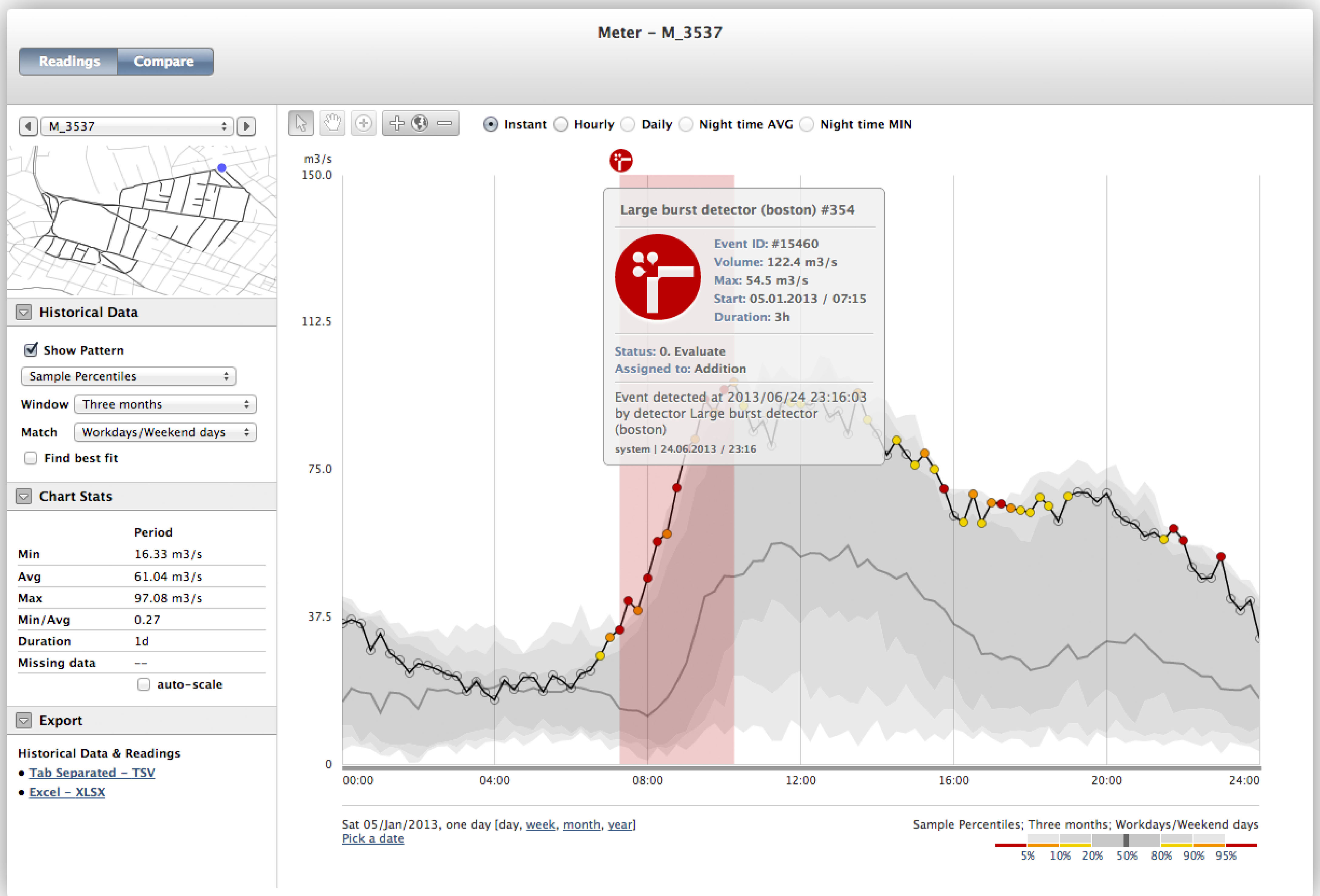
Inspection analysis
Using system condition assessment records, such as from CCTV inspections, predict present and future condition, and intelligently guide the inspection effort.

Infrastructure Value Index
Analyse the ageing degree of an infrastructure as a ratio between the current and replacement values of its components, and project short- and long-term investment needs.

Performance Indices
Simulation-based, detailed technical performance assessment, such as water quality and energy system behaviour.

Open-source baseform.org software and research has been funded by:

AWAREP» trust iGPI WERF iPerdas



Introduction

The technical management of water supply and wastewater/stormwater utilities has for decades been supported by a range of well-established software families, such as GIS, SCADA, asset maintenance management, inventory or customer management. A common feature of these softwares is their generalist nature, with a DNA mostly originating in other industries. This legacy increasingly shows its limitations whenever alternative, dedicated solutions are able to take advantage of the very specific, system-connected nature of networked infrastructures, leading to clear efficiency gains. Another consequence of a fragmented origin is the frequent coexistence of multiple sources of the truth across the company's information systems, and the absence of viable, vertical cross-checking mechanisms. The heavy reliance on a proprietary logic, on the personal-workstation paradigm and on the licensing schemes built around it also represent a growing obstacle to the integration of information and engineering process. All three conditions have become major limiting factors as the market pushes for greater integration and total focus on process efficiency, in view of ever harsher demands on quality of service and financial and environmental sustainability.

Conversely, scientific and academic R&D does not easily reach the professional environment of water utilities. Many useful innovations and good ideas with the potential to represent effective gains and return on investment, are lost to the fragmentation of research bodies and to the brief attention span of degree dissertations. This is particularly felt in the software solutions field, giving rise to a multitude of short-lived academic or applied research prototypes that seldom find their way into viable professional solutions.

Baseform.org's combination of collaborative software technology with leading-edge scientific research results in clear efficiency gains. A specific scenario demonstrating the potential of coherent, dedicated software is the alliance of advanced flow monitoring solutions with failure analysis and prediction, leading the way to increased ROI.

Material and Methods

Baseform.org is a software platform that aggregates solutions for water supply and wastewater/stormwater system management. The software is developed from scratch focusing on an integrated vision of processes, objectives, data and workflows.

The applications on Baseform are new and innovative both from the technology viewpoint – cloud-based, accessible to anyone anywhere – but above all, through the incorporation and development of strategically aligned science and engineering methods, in solutions that directly address water service processes, rather than adapting from generalist software. Several of the platform's solutions have an open-source nature, giving back to the community the essence of the engineering methods incorporated, and opening them to crowd-sourced validation and innovation.

Baseform's platform is based on a shared set of functionality and services (Baseform CORE), including data management, common user interface and network/data visualization environment. Smart data applications are developed as plugins to the CORE environment, co-existing and seamlessly sharing data and results.

A case in point, that demonstrates the value of this approach for substantial ROI through the aggregation of traditionally segregated capabilities, is the relationship between the app for flow monitoring and analysis present in Baseform, and the advanced infrastructure asset management analysis and planning solutions also available in the platform under the AWARE-P portfolio (Alegre et al., 2013; Coelho et al., 2013).

Real-time flow monitoring is an increasingly central activity for both water supply and wastewater/stormwater utility services, more frequently found in the former for operational purposes in the realm of SCADA systems. More recent solutions have been proposing automated leakage event detection, water balance and tracking of water losses, bridging towards field leakage detection programs.

Baseform's flow monitoring app was developed in the latter scope, coupling real-time analysis with advanced statistical model-based profiling to comprehensively analyze and characterize normality as a means to enable effective detection of outlier events that may represent leakage and other operational conditions (Mamade et al, 2013).

On the asset management and planning scenario, significant advances have been made in recent years, namely on pipe failure analysis and prediction. Linear Extended Yule Process (LEYP) is one of the most advanced models currently available (Le Gat, 2009), a counting process where the intensity function depends on the age of the pipe, the number of past events and a vector of covariates, resulting in failure rate and probability estimation for each individual pipe along time. LEYP is available in Baseform's failure analysis tool. Users of this tool learn to value the quality and depth of failure event records.

The accuracy of the results of both leakage detection and failure analysis depends on the quality of available data. The classification of detected outlier flow events drives the gathering of a reliable and updated history of failures. This information feeds failure prediction which in turn produces the best possible estimate of the probability of failure of each individual pipe. In one direction, operational leakage detection is informed by narrowing down on statistically problematic areas; in the opposite direction, reliable failure records are gathered and confidence on failure prediction results is progressively improved.

Results and Conclusions

Although leading-edge on their own, the true ROI potential of both apps described above becomes apparent at the Baseform level.

Experience shows that operational leakage control is only a partial cure to the water losses problem, which is only appropriately handled in the wider scope of infrastructure asset management and rehabilitation. Other instances of platform induced integration of traditionally separate processes resulting in efficiency gains include:

1. Flow monitoring gains extra value when informing, and informed by, network models; enter native integration with a from-scratch Java implementation of the industry standard, Epanet;
2. Effective infrastructure knowledge is best afforded through visualization and exploration of the asset geodatabase and of the work orders that record asset interventions; connect to Baseform's integrated GIS, designed from scratch for urban water networks;
3. Modeling and estimating long-term infrastructure capital investment and rehabilitation needs, and its impact on utility sustainability policies – available in a Baseform financial modeling app – gains deeper focus when informed by life expectancy predictions obtained from pipe failure analysis;
4. A decision-support solution is present in Baseform – through the PLAN metric-driven framework for evaluating, comparing and negotiating competing intervention strategies, through performance, risk and cost assessment metrics — where any of that information can natively be used to support globally viewed decisions.

What has been achieved with Baseform is a long-term R&D roll-out strategy, connecting software development with the industry and a network of public research organizations, that has allowed for an alignment in successive projects, with a consistent generation of funding for a coherent line of solutions around some of the main engineering and management processes in urban water utilities.

By addressing the practical data needs of the various organizational levels, collaborative software can be a driver for vertical integration and alignment in the decision-making process, which at present lacks coherent vehicles in most utilities. In practice, the usage of this software paradigm in urban water utilities has resulted in measurable alignment of operational, tactical and strategic objectives, processes and users (e. g. Leitão et al., 2013).

References

Alegre, H., Coelho, S.T., Covas D., Almeida, M.C., Cardoso, M.A. (2013). A utility-tailored methodology for integrated asset management of urban water infrastructure. Water Science & Technology: Water Supply, (in press) ©IWA Publishing 2013.

Coelho, S.T., Vitorino, D., Alegre, H. (2013). AWARE-P: a system-based software for urban water IAM planning. IWA LESAM 2013, 10-12 Sep, Sydney, Australia.

Le Gat, Y. (2009). Une extension du processus de Yule pour la modélisation stochastique des événements récurrents. Application aux défaillances de canalisations d'eau sous pression. Ph.D. thesis, Cemagref Bordeaux, Paristech.

Leitão, J. P. et al. (2013). The iGPI collaborative project: moving IAM from science to industry. LESAM 2013, IWA / AWA, 9-12 Sept., Sydney, Australia.

Mamade, A. et al. (2013) Spatial and temporal forecasting of water consumption at the DMA level using extensive measurements. CCWI 2013. Perugia.