Bloor

White Paper

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IBM Informix and the Internet of Things

"IoT architectures are evolving into three tier environments where processing is required at the edge – in devices – at collection points – in gateways – and at the centre. (However) in practice, not all devices need to be smart, and not all environments require more than two tiers: it will depend on the application."

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Executive summary

Informix, one of the databases offered by IBM, has a long and illustrious history. In particular, it is well known as a platform for supporting applications developed by third parties and ISVs, primarily for use in transactional environments. This is because Informix is a robust offering that combines high performance and functionality with minimal administrative requirements. However, this paper does not discuss these features of the product in any detail. Instead, we are here concerned with the use of IBM Informix within Internet of Things (IoT) environments. Indeed, we can start by saying that IBM Informix is IBM's database of choice for IoT deployments, which should be reassuring to any existing users that might have been concerned about continuing investment into this database product.

We will start with a brief discussion, not of IoT per se – an understanding of IoT is assumed – but of the different ways in which databases may be employed within IoT environments. Briefly, IoT architectures are evolving into three tier environments where processing is required at the edge (in devices), at collection points (in gateways) and at the centre. In practice, not all devices need to be smart, and not all environments require more than two tiers: it will depend on the application. For example, a "smart meter" typically does no more than forward a reading to a collection point and perhaps provides some limited information about usage for the householder. Conversely, you might have embedded database capability in a cell tower that is intended simply to identify dropped calls or in a wind turbine that will adjust turbine blades according to pre-defined rules based on atmospheric conditions. Then again, in a preventative maintenance scenario, sensors not only provide readings to a collection point for analysis but will also need to be able to raise alerts based on pre-defined conditions. Thus there is a wide spectrum of requirements, but as a rule of thumb, for large deployments, it is reasonable to work on the basis that some sort of intelligence is required in each of these tiers but the closer to the centre you go the more advanced the requirements will be. From a database perspective, these may be embedded in either or both of the first two tiers. At the centre there will typically be a requirement to support hybrid operational/analytic requirements and there may also be a need to provide conventional data warehousing capabilities for longer-term analysis of data that has been collected. It is also worth bearing in mind that you may want to deploy your centre-based database(s) in the Cloud rather than on-premises.

In the following sections we will consider the sort of facilities that are required to support these different environments, along with a consideration of the features of IBM Informix that lend themselves to such deployments. We will conclude with a discursion into areas where IBM Informix has special abilities, not generally available in other database products, which especially support IoT environments.

> **Informix is a robust offering that combines high performance and functionality with minimal administrative requirements.**

Figure 1: IBM Informix can be embedded at device level, in gateways, and used for central processing

Embedding

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As mentioned in the previous section, IBM Informix has a long history of being embedded in a variety of applications and this suggests that the product is easy to implement and deploy. Going beyond this, while there are many similarities between embedding a database into a general-purpose application and embedding a database into a device or gateway, there are also differences. In particular, at the device level database footprint is a major consideration and for both devices and gateways cost is an issue, as often there may be thousands of devices each running an instance of the database. In the case of the former, the footprint of IBM Informix is just 100 Mb to install on disk while IBM provides free developer editions to hardware manufacturers (such as Cisco and Intel, both of which are partners) and charges as little as a few dollars for OEM vendor distribution.

More generally, the main requirements for embedding a database are that you can fire it up and forget about it, that it performs adequately, that it is robust and does not fall over, that it is flexible enough to support deployments in different types of devices and gateways, and that it is easily updated (without appreciable downtime) when requirements change. In so far as IBM Informix is concerned all of these can be taken as given. However, there are a couple of points worth discussing.

Firstly, it is essential that any embedded database is invisible and remains that way. This is true regardless of whether you are simply collecting data and passing it on or whether you are performing some analytics on the data. In the latter case, in order to get good performance, you need, at least in conventional environments, to create indexes, materialised views and other such database constructs in order to achieve that performance. While this is feasible it is not flexible in the event that additional requirements need to be supported. Every time you add functionality within the device or gateway you will need to change the supported indexes. Worse, different workloads may mean that different indexes, materialised tables and so forth will be differently suitable for different customers. Moreover, these workloads may change over time. What this will mean is that the database will need to be tuned on an ongoing basis in order to maintain performance, which is impractical in IoT environments. For all of these reasons a traditional relational database will not be suitable for embedding at the device or gateway level, precisely because these all require exactly this sort of tuning. Fortunately, this is not the case with IBM Informix because the product includes self-healing and self-tuning autonomics that handle these embedded environment requirements automatically.

Secondly, there are some elements of database flexibility that need to be discussed with specific respect to IoT environments. Support for things like geo-spatial and time series data we will discuss later. In the context of flexibility, you must bear in mind that an IoT implementation may consist of multiple types of devices and gateways doing different things. Moreover, the sort of data you are collecting and processing may change over time. For both of these reasons a database that supports a flexible schema will be preferable and as a result of these considerations IBM Informix supports JSON (where each data object has its own schema) as first class objects within the database. This is important not just from a flexibility perspective but also because JSON is commonly used as a data exchange medium from devices and gateways. Moreover, IBM has recognised that there is substantial existing use of MongoDB within the IoT community, so it has also implemented API compatibility with MongoDB, a wire listener that acts as a mid-tier gateway between MongoDB and IBM Informix, and the database supports BSON (binary JSON), which is the form of JSON supported by MongoDB. Again, BSON is treated as first-class.

Analytics and analytic applications

We need to distinguish between analytics and analytic applications. The difference between these two is that the latter provides a packaged approach whereas the former is more tool-based. Analytic applications may be deployed at any level within an IoT environment whereas analytics per se will typically only be required at the centre. If you consider that processing at the edge and at collection points is going to be automated then this makes sense: it is only at the centre that people, as opposed to processes, are going to want to query and investigate the data that has been collected.

Given its history of supporting third party vendors, IBM Informix is especially targeted at analytic applications although, of course, it supports business intelligence and data mining tools such as IBM Cognos, Watson Analytics and SPSS as well as products from other suppliers. Note that in the centre, it may be the case that analytic applications have ad hoc query capabilities built-in to complement the various pre-designed queries, reports and other functions that form the mainstay of the application.

From a functional point of view, we need to consider analytics and analytic applications separately. Analytics has traditionally been thought of as separate and distinct from operational or transactional functions. However, that doesn't have to be the case. In smart metering environments, for example, you are collecting data that you need for transactional (billing) but which you also want to analyse. While this may make sense from a logical (and business) perspective it requires a database platform that has been optimised to support such hybrid environments and the truth is that most databases can't do this within a single environment. The big advantage, of course, is that you only require a single system with a single hardware implementation if you can support a hybrid environment, which potentially means reduced up-front costs. This is sometimes referred to as Hybrid Transaction/Analytic Processing (HTAP). It has the additional advantage that you don't need to move data from one environment to the other and there is no need to synchronise the data. Furthermore, a single set of administrative requirements means lower on-going costs, but it is this that represents the catch for most database products because the majority of relational databases that are suitable for both transactional and analytic operations on a separate basis require very different tuning and administrative requirements to optimise performance for both environments in conjunction. Thus it becomes impractical to implement such a hybrid system. However, as we shall see, IBM Informix is an exception to this general rule.

Analytic applications in an IoT environment are pre-built but also tend to be hybrid in nature, typically combining sensor-based or machine-generated data into applications that have both operational and analytical implications. An example is smart metering. Another common example is in motor insurance, where companies are increasingly installing telemetry into vehicles to monitor the quality and speed of driving, which can lead to a bonus for the driver if he or she drives well. These types of applications often include a real-time or near real-time element. For example, in the example quoted the collection of the data needs to be real-time to support notification of emergency services in the event of an accident (sudden deceleration followed by lack of movement). Similarly, you may require support for geo-spatial data and/or time stamps, where it is important to know the location and/or time at which something happened.

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Key features

Having defined, at a high level, the unique requirements of IoT applications, it is time to turn our attention to IBM Informix in more detail. We have already discussed some aspects of that product, most notably its support for flexible schemas, but there are a number of others. In particular, there are key features of IBM Informix that lend themselves to IoT environments, which we will discuss in turn. However before doing so it is worth emphasising that all of these features are part of a single platform that can be implemented within a single instance of the database.

Flexible Grid

For those requiring high availability and/or scalability – and bear in mind that IoT applications will often be mission critical – IBM Informix includes a capability known as Flexible Grid as well as High Availability Data Replication, Remote Secondary Standby Database Servers and Shared Disk Secondary Servers. While the last three of these should be self-explanatory the Flexible Grid may need some explanation. The Flexible Grid supports the definition of a multi-node heterogeneous cluster that makes it possible to run an application on any node within the grid. This means that you can have a geographically dispersed environment with different commodity hardware (and operating systems) implemented in different locations, according to need, and yet have the whole environment centrally controlled. Not only are DML operations replicated, but so are DDL operations. This means that when a table is created on one node, it is automatically created on all nodes within the Flexible Grid. In addition, it is possible to automatically start replication of the table as soon as it is created, which greatly simplifies the deployment of a replication solution. A major feature of the Flexible Grid is that it supports continuous availability. That is, operations can continue regardless of whether downtime is planned or unplanned. For example, Game Show Network uses the Informix Flexible Grid and – at the point that we spoke with them – had had no unplanned (or planned) downtime for two years. According to Susan Marciano, Vice President of Technical Operations *"the Flexible Grid feature of Informix enables us to perform rolling upgrades without any outages, so players can go on playing with no interruption and no impact on our revenue. That's worth its weight in gold."* Other use cases occur wherever 24x7 operations are critical and, especially, where costs are a major factor, since the Flexible Grid runs on commodity hardware. Minimal administration is a further major benefit.

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Warehouse Accelerator

IBM offers various Warehouse Editions of Informix. These all include the Informix Warehouse Accelerator (IWA) to support analytics. This is an extension to the normal database used for transactional purposes and will typically be required in hybrid environments where you need to support both transactional and analytic processing within the same IoT scenario. IWA enables query processing in-memory and provides a column-based approach to avoid any requirement for indexes, temporary space, summary tables or partitions. In other words, it is entirely suitable for supporting analytic applications because the lack of these features means that administration is both minimised and consistent across transactional and analytic environments. The Warehouse Accelerator can be implemented on the same system as the relevant transactional environment. For hybrid environments you use Smart Analytics Studio, which is a graphical development tool, to define the data (and its schema) that you want to query and the Warehouse Accelerator will automatically offload this data, which is now stored separately from the OLTP environment. It is processed in its own memory space so that there is no conflict with the operational aspects of the environment and transactional performance will not be impacted. Note that there is no need to change your existing business intelligence tool(s). There are a number of other features worth mentioning:

- The Accelerator uses vector processing. This is a form of processing that takes advantage of modern day CPU characteristics, which is orders of magnitude faster for computationally intensive tasks, which analytics frequently are.
- The database optimiser has been specifically optimised to support both transactional and analytic workloads where a hybrid environment is being deployed. It is also worth noting that the optimiser knows where the data is and where it is not. The optimiser determines whether the query can be satisfied by the Accelerator and, if so, it routes the query there. If not, it will choose to execute the query within Informix itself. Now, if a query saves the result into a temporary table as part of the Select statement, as is often done by certain BI tools, then the Accelerator can speed up that portion of the query.
- In-database analytic capabilities are available from Fuzzy Logix, which has ported its library of analytic and statistical capabilities to run within the IBM Informix database.
- Informix itself uses the same deep compression technology as DB2, which provides benefits both in terms of storage capacity and performance. A proprietary encoding method (approximate Huffman encoding) allows predicate evaluation without having to decompress the data. This is a substantial advantage where memory is limited, especially at device or sensor level.

Finally, it is also important to appreciate that the Warehouse Accelerator supports not just relational, structured data but also analytics against other forms of data, most notably JSON and BSON, as already discussed, plus time-series data, which we consider next.

Time series and geo-spatial data

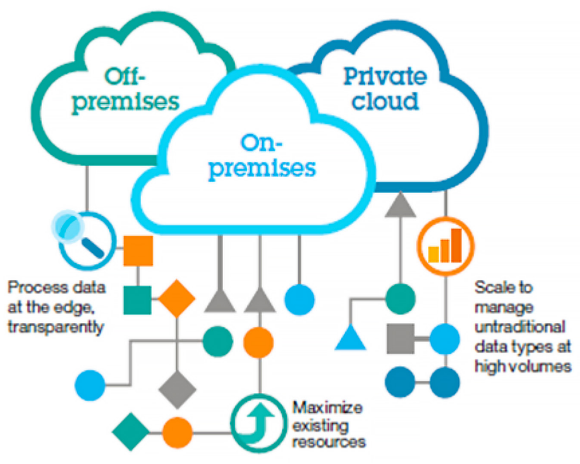
There are many applications that require an understanding of time. For example, in capital markets you need to know when a trade was initiated and when it was completed. In smart metering and other sensor-based environments you will be taking measurements on a regular basis and you need to know what value was recorded and at what time. You also need to handle data that arrives out of time sequence. Bearing in mind that measurements are taken every 15 minutes, say, it would be wasteful to record a time stamp for every single measurement: it is more efficient to simply store the start date and time, and record what the time interval between measurements is. This is what is known as a time series and it is a native capability of IBM Informix. It saves disk space and will provide better performance characteristics when querying the data. While there are certainly a number of data warehousing products that natively support time series there are few, if any, transactional, relational databases, apart from IBM Informix, that have native time series capability.

Geo-spatial support is important in a number of IoT-based environments. For example, in logistics, where you are tracking (and re-routing) delivery vehicles. Geo-spatial capabilities are more widespread than time series support but are still limited, with the majority of supporting vendors being in the data warehousing space.

Cloud deployment

Many IoT implementations will employ a cloud component and it is therefore relevant that IBM Informix runs in the Cloud, on any suitable PaaS (platform as a service) environment, including Amazon, Microsoft Azure as well as IBM SoftLayer. A multi-tenancy approach is supported and, in the latest release of the database, there are specific enhancements in this area, including the ability to limit memory and connections for client databases and to restore tenant databases to a point in time. It is also worth noting that IBM Informix is the engine behind the IBM Watson IoT Platform, which brings cognitive computing to IoT environments.

Figure 2: IBM Informix can be deployed as required



Conclusion

IBM Informix is widely deployed in transactional environments but is less commonly used as a traditional data warehouse. The purpose of this paper has been to examine its suitability for supporting IoT environments, either as an embedded database at the edge or in collection points, or in the centre. Depending on where it is implemented there will be rather different requirements. However, in our opinion IBM Informix is well-suited to IoT regardless of where it needs to be deployed. At the device and gateway level the product has a long-standing reputation as a "fire and forget" database that can be easily installed and maintained while, in the centre, it has the sort of capabilities and performance characteristics that suit hybrid operational/analytic environments. On top of this, native time series and geo-spatial support are requirements for many IoT use cases, so IBM Informix is well-placed in this market.

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FURTHER INFORMATION
Further information is available from
www.BloorResearch.com/update/2293

About the author

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Philip started in the computer industry way back in 1973 and has variously worked as a systems analyst, programmer and salesperson, as well as in marketing and product management, for a variety of companies including GEC Marconi, GPT, Philips Data Systems, Raytheon and NCR.

After a quarter of a century of not being his own boss Philip set up his own company in 1992 and his first client was Bloor Research (then ButlerBloor), with Philip working for the company as an associate analyst. His relationship with Bloor Research has continued since that time and he is now Research Director, focused on Information Management.

Information management includes anything that refers to the management, movement, governance and storage of data, as well as access to and analysis of that data. It involves diverse technologies that include (but are not limited to) databases and data warehousing, data integration, data quality, master data management, data governance, data migration, metadata management, and data preparation and analytics.

In addition to the numerous reports Philip has written on behalf of Bloor Research, Philip also contributes regularly to ***IT-Director.com*** and ***IT-Analysis.com*** and was previously editor of both ***Application Development News*** and ***Operating System News*** on behalf of Cambridge Market Intelligence (CMI). He has also contributed to various magazines and written a number of reports published by companies such as CMI and The Financial Times. Philip speaks regularly at conferences and other events throughout Europe and North America.

Away from work, Philip's primary leisure activities are canal boats, skiing, playing Bridge (at which he is a Life Master), and dining out.

Bloor overview

Bloor Research is one of Europe's leading IT research, analysis and consultancy organisations, and in 2014 celebrated its 25th anniversary. We explain how to bring greater Agility to corporate IT systems through the effective governance, management and leverage of Information. We have built a reputation for 'telling the right story' with independent, intelligent, well-articulated communications content and publications on all aspects of the ICT industry. We believe the objective of telling the right story is to:

- Describe the technology in context to its business value and the other systems and processes it interacts with.
- Understand how new and innovative technologies fit in with existing ICT investments.
- Look at the whole market and explain all the solutions available and how they can be more effectively evaluated.
- Filter 'noise' and make it easier to find the additional information or news that supports both investment and implementation.
- Ensure all our content is available through the most appropriate channels.

Founded in 1989, we have spent 25 years distributing research and analysis to IT user and vendor organisations throughout the world via online subscriptions, tailored research services, events and consultancy projects. We are committed to turning our knowledge into business value for you.

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