Comparative Analysis between
Boardwalk's Digital Ledger Database and
Traditional Database Applications

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BOARDWALKTECH
Enterprise.Blockchain.

APPLICATION FLEXIBILITY& MAINTAINABILITY

Point solutions are custom built using a specific methodology (schema) for a given application/problem area. As the business grows, these methodologies evolve or change completely which traditional database application systems cannot easily accommodate. On the other hand, Boardwalk is a flexible digital ledger business modeling environment that can be easily adapted as business requirements evolve.

Boardwalk:

- Boardwalk is a patented digital ledger database technology which supports multi-party collaboration and verification on a trusted, shared, secure, private information cloud.
- The main distinction is that the Boardwalk digital ledger database engine is driven by a time-based grid of positionally related data where all updates are inserted into the digital ledger creating a transaction blockchain.
- All transaction updates are captured on a net-change basis with an irrefutable transaction ID and crypto hash.
- This means that if the process subject matter expert changes the application business model (which can be done in Excel or any authoring environment), the Boardwalk database automatically adapts itself to that change without programming.
  - o Boardwalk offers a WYSIWYG interface to the process expert, empowering them to change the process quickly.
- This is a significant difference with respect to other applications where any change requires the subject matter expert to communicate changes to an OLAP/DBA expert who has to make changes and complete a development cycle to execute on the changes. Any such change would require weeks or months and would be quite expensive.
- The process expert can make the following changes in the Boardwalk database, add rows, add columns, change the position of columns and rows, and express complex business rules. Once they complete these changes and go through the test and verification process, the changes can be published to the users. This process can be complete in matter of days.
  - o This allows the Boardwalk application to quickly adapt to changing business and process conditions.
- The Boardwalk database allows the creation of new business entities on the fly. For example, one can add a new model to do inventory management for new SKUs in matter of days and deploy it in weeks.
- End users can also express their own business logic as formulas to capture their planning data as a trend or a formula based on a critical data feed. Formula based logic also provides powerful, business user friendly smart contract modeling capabilities for blockchain and other enterprise applications.
- From a business perspective, Boardwalk allows the usage of different business formulas or logic for different business dimensions within the same data environment. This means Boardwalk supports mixed time hierarchies which can be used in the planning models.

Traditional Database Applications

Traditional database applications are built on SQL tables and have a web interface to present the data that is in the SQL tables. This means that this is a three-layered approach, i.e. the middle layer transforming the data layer to the object model on the user interface. This means to make any change to the system, like addition of an extra field, all three layers will be affected.

- Any change in the data model or any new addition of a business object would require the following steps
  - o The planner writes a spec about the change request
  - o The traditional database application IT team designs the changes to the SQL schema to accommodate the new change whether it is a new column or a new data view (if that is even possible)
    - ▪ The traditional database application will not be able to support different formulas and logic for different parts of the hierarchy.
  - o The IT team changes the webpage to accommodate for the new column or calculation or a whole new tab to capture the new worksheet.

- They also try to position the fields on the webpage based on the planner's request.
- This change request takes a few months to execute and the change is only available to the end users in the next release of the application.
- As it takes a long time to accommodate changes, in many cases the planner decides to run a parallel process to adapt to changing market conditions. <u>This means requirements changes cannot be easily accommodated.</u>
- It is difficult for planners and end users to add their "personal" business rules to the database.

OLAP/Data Warehouses

- By nature, OLAP engines are designed for reporting and not for collaborative applications.
- OLAP engines assume very well-designed fact tables on which one can build a reporting model.
- All this means that one has to clearly understand the business requirements to model the fact tables correctly.
- This process is time consuming and any change in requirements extends the development time. And, as business conditions change, it would start to deviate from user requirements. As a result, people tend to move away from these systems.
- The user interface is driven by the SQL joins between the fact tables and offers limited flexibility to position important business data or to easily add calculated fields etc. This is because SQL does not naturally support an OLAP data model.
- Any new requirement (like adding a new column or a row or a new business entity) will require the full development cycle of
  - Schema design
  - UI design
  - Integration
  - Test and deploy
- Many of these applications claim flexibility and yet it takes a few months or years and significant cost to implement the system.
- The time and material costs to implement these applications goes in either adapting the tool to the customer's process or adapting the process to the tool.

UI FLEXIBILITY

A ledger-based data interaction environment (such as found in Excel) is unquestionably the most flexible and powerful business process user interface. In these environments, position matters and Boardwalk is the only solution which elevates the ledger-based experience to enterprise quality. Any other solution can only simulate the rich experience of a ledger-based application.

Boardwalk

- Ease of use
  - Users interact with grids of positionally related business data – the Boardwalk Digital Ledger - most often in Excel.
  - Users can use drag and drop, filter, review multiple objects, and even use formulas to enter their data within the Boardwalk digital ledger.
  - This results in minimum training and change management.
- Simulation
  - Users can edit the plan with multiple scenarios and keep multiple copies of the data.
  - Users work in isolation until they are ready to share their changes
  - Since Excel is an open system, there is a wealth of simulation and math capabilities available.
  - Boardwalk opens the possibility to use all of these for simulation and analysis with minimum effort by the business user.
  - Business users can also use Excel reports to perform what ifs and analysis which can all be retained offline and persist.

- Business Template
  - Boardwalk can use desktop Excel or any tabular UI as a container to deliver the application to the planner
  - The business template includes data, business logic, layout, formats and business logic to deliver a customized user experience.
  - The Boardwalk template layout can be configured to show summary data, graphs, low-level SKUs, and filters in a single worksheet which is easily managed by the business user. Other applications use HTML frames to emulate this capability.
  - Deployed templates can be updated automatically.
- Offline usage
  - From our experience it is very important to offer an offline capability for all the above to planners for the following reasons
    - Performance is incomparable with respect to server-side calculations.
    - Planning activity is not like simple data entry—it requires business logic calculations.
    - A web session timeout can lose all the data.
    - Users need to save data locally and do what-ifs before they submit the data.
    - To create a real simulation, one needs to edit large amounts of data across multiple SKUs to create and save realistic scenarios. This is impossible without Excel.

Traditional Database Applications

- Ease of use
  - HTML UI is difficult to use because you can only tab between forms.
  - Adjustments of data view widths is very difficult.
  - Because of these limitations, the only realistic comparison is only if the applications have an Excel frontend.
  - There's no local what-if/save-as capability—you cannot mature data offline.
- Simulation
  - Simulation needs to be done on the server side which is only as good as the calculation environment of the server.
  - Typically, these environments do not compare with the capabilities of Excel on the desktop with its rich simulation libraries.
  - Storing different simulation scenarios on the server takes up considerable system resources.
- Flexibility
  - The data model on the server side is rigidly presented in HTML
  - The HTML is not editable by the end users (one cannot add a new worksheet for local data)
  - In HTML, there is no local data processing which the user can leverage and persist
  - The server-side data model is rigid, therefore even the Excel frontend becomes inflexible
  - Frames and other user interface elements are not easily adjusted by the business user as the process changes nor can they be customized for a single user

INTEGRATION

Since Boardwalk is a positional database, it offers a standardized interface which can be easily applied to any data and process environment.

Boardwalk

- Flexible integration environment designed to work with any schema/data model.
- Support for net changes at the cell level in both directions.
- Quick integration into user defined desktop models.
- SQL integration for large data movement.
- Integration is persistent which means updates due to integration are tracked at the cell level and are available for reporting and understanding business drivers.

- Easy to setup & maintain.
- Compatible with industry standard integration tools (Tibco, ETL, Informatica).
- Integration can affect data model changes (periodic shifts, new products).
- UI design and integration can be mutually exclusive.
  - Integration does not drive the user interface (data all in rows).

Traditional Database Applications

- Supports full data updates only.
- Difficult to setup and maintain (expense, time, complexity).
- Passive reflection of the rigid data model and cannot change the data model within integration.
- Integration is focused on the fixed data model of the specific application.
- Any change to the process will affect all the integration points.

SCALABILITY

Since Boardwalk distributes processing across the desktop and server, it is more scalable than a server-centric application

Boardwalk

- Excel, J2EE, and SQL Server are proven scalable components
- Because of the local Excel calculation and rendering, Boardwalk distributes computational load across desktops and server
- Offline mode allows the system to scale with more users on a single Boardwalk Server
- The server is only busy when user submits the data
- A stateless environment allows you to create a load balanced server environment
- Only net changes travel to the server, so bandwidth and server load for updates is minimized

Traditional Database Applications

- Server side, in-memory OLAP cubes are performance killers
- Multiple users require multiple session loads resulting in locking of hierarchies and limiting concurrent usage
- Performance limitations often impose process changes to limit the amount of data
- These systems often rely on bookmarks to limit the amount of data loaded resulting in 100s of bookmarks
- Work-in-progress session storage creates immense loads on server resources

WIDE SOLUTION PLATFORM

Much like Excel, Boardwalk can be used for virtually any application unlike point solutions which are application specific.

Boardwalk

- Boardwalk can support your models and processes and not force you to change your process or models to adopt the tool.
- A single platform environment can be used to support multiple processes on any platform.
- Boardwalk can enable processes outside the firewall.

Traditional Database Applications

- Point solutions specific to a given application.
- Solution modules are not easily customized to match user process requirements.
- DBA/J2EE/Web resources are required to extend platform.

COST

Boardwalk's cost of ownership is low due to its flexibility and wide application fit.

Boardwalk

- WYSIWYG allows reduced TCO
- Nth change to the process is fast and low cost
- Implementation schedule 1-4 months

Traditional Database Applications

- Server-side components to support scale are significantly more expensive than expanding desktop computational resources.
- Changes to functionality and/or data model are expensive
- Time to deploy ultimately impacts the business opportunity cost
- Training costs are high

USER INTERFACE PERFORMANCE

For planners that work with large amounts of data on a day-to-day basis, web interfaces that were originally designed for HTML forms with 50 fields and information/text displays are not suitable. In the end, the adoption and quality of data suffers immensely in web-based planning systems and users go back to using Excel to mature their data offline. This means choke points develop in the company's overall planning process.

Boardwalk:

- Boardwalk has demonstrated the following performance metrics using a live server with fully loaded dataset.
- Although the template had a significant amount of formulas, when the users edited the data, the template met the 3 second response time required for responding to calculations.
- This meant that the planner can edit multiple SKUs across multiple time horizons in a matter of seconds.
- When a planner submits data to Boardwalk, they can change as much as 1,000, 2,000, or 10,000 cells and the submit/refresh times given below will hold true for all updates.

Size	Download	Submit	Refresh	Rows X Columns	Cells or Fields
100 SKU	< 1 Min	1-2 Min	< 1 Min	3600 X 87	319k
300 SKU	1-2 Min	2-3 Min	< 1 Min	10200 X 87	887k
1000 SKU	5-6 Min	3-4 Min	1-2 Min	30222x87	2.6 M

Traditional Database Applications

- Data size for traditional server/thin-client browser applications
  - In our customer's experience with web-based user interfaces, they have seen that the performance to load the page significantly degrades beyond 1,000 fields of data.
  - In a planner workbook, each SKU needs 30 measures X 80 time columns or about 2,400 fields of data in the webpage.
  - Because of the web-based forms constraint, these web interfaces tend to show and edit only one SKU at a time and it is impossible to do an apples to apples speed comparison with Boardwalk.
- Calculation Performance
  - Basic HTML will not support dynamic calculations i.e. as user enters data other calculated fields change
  - These apps tend to use Applet technologies to emulate Excel calculation engines or they would make a server request to calculate and return the results
  - The calculation engines custom built in these applets are significantly slower as compared to Excel.
  - The calculations done on the server side will be slower as compared to Excel.
- Edit performance
  - HTML user interfaces offer no drag and drop edit capability like Excel so one has to click or tab from field to field.
  - Applet user interfaces do offer drag and drop functionality but it is significantly slower than Excel.

OLAP/Data Warehouses

- In memory OLAP cubes load all the data into memory on the server to perform their calculation tasks.
- This takes a high-end server and lots of lots of memory to support concurrent usage.
- Traditionally this leads to very slow user experience.
  - We have seen a number of installations with lot of complaints about performance due to in memory OLAP cubes.

Excel front-end user interfaces

- Many apps have Excel frontends.
- These need to be compared with submit refresh times of Boardwalk
- In our estimate, because of the conformance of the backend model with Excel front end, Boardwalk will be faster.
- Materializing the application data model, including formulas, inside Excel is slow and unidirectional.