# Data Visualization for Hybrid Application: The Challenges in Choosing an Optimal Library for Line Chart

**Sambit Kumar Patra, Ishita Gupta, Gaurav Saini, Vinodkumar Poolothvalappil**

***Abstract—Developing application using web-technology for cross-platform becomes trend these days. However representing data into a small space is more challenging. Digital convergence has led to a sudden dependence on the mobile devices. The data visualization on mobile devices needs to be in a very pristine manner. To achieve that, unique methods are looked upon that generally involve simple but effective presentation instruments such as tables, charts and graphs. So, the challenge comes in deciding and choosing the right charting library for the hybrid mobile application looking over the cost, functionality, performance, and user experience. This paper has illustrated the challenges faced in implementing line chart in hybrid application using Fusion, HighChart, Rickshaw and D3 chart and will help in deciding the best charting library for the same.***

***Index Terms—Cross-Platforms, Chart Libraries, Comparison, Data Visualization, Hybrid Application, Line Chart, Fusion, HighChart, D3***

## I. INTRODUCTION

The rising of digital technologies and the continual growth of mobile app market has led to more dependence on the mobile devices. The mobile apps are growing exponentially in the market, as they provide a flexible solution to access the data. The hybrid mobile apps prove to be very useful as they are easily extensible over multiple OS and mobile devices with a universal user interface. A modern day hybrid application may require a lot of data to be showcased and visualizing that data in a well-groomed format is need of the hour. Visual Data Exploration usually follows a three step process: Overview first, zoom and filter, and then details-on demand (which has been called the Information Seeking Mantra [1]). First, the user needs to get an overview of the data. In the overview, the user identifies interesting patterns and focuses on one or more of them. For analyzing the patterns, the user needs to drill-down and access details of the data. There are large numbers of data visualization techniques. In addition to standard 2D/3D-techniques such as x-y (x-y-z) plots, bar charts, line graphs etc. [2], there are a number of more sophisticated visualization techniques [3]. On mobile platforms, users are also in need of support for touch events to focus nearest points. Charts are often used to ease understanding of large quantities of data and the relationships between them. Charts can usually be read more quickly than the raw data that they are derived from. For continuous data, the line chart is more preferable than other charts [5]. To represent huge data on mobile device, we are using line chart in this paper as one of the reference charts to deploy in the hybrid application. The paper explains the capabilities, incapabilities and challenges faced while presenting such data and also while implementing touch, zoom and pan features using highly recommended chart libraries such as Fusion, HighChart, Rickshaw and D3 chart in hybrid applications. The applications using above libraries have been verified on Android and iOS platforms with Samsung S4, Samsung S3, Samsung Galaxy Tab 4, iPhone 4S, iPhone 5 and iPad devices.

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## II. PROBLEM DEFINITION

Before digging deep, following are the main features we have considered for comparison while choosing the optimal charting library:

Line chart– A line chart or line graph is a type of chart which displays information as a series of data points called 'markers' connected by straight line segments[5]. Sometimes, a group of line charts are required for plotting to check the variance among them.

Zooming– Zooming for layman is un/magnifying a subject to look into it more effectively. For data-rich graphs, zooming lets the user view a data more precisely. Starting with the macroscopic view, user can use the zoom feature of the chart to have a microscopic view of the data.

Legend – When a chart contains varied type of data, the chart may include a legend. A legend contains a list of the variables appearing in the chart and notation of the data representation using unique color coding [5].

Tool tip/ Labels– In a chart, the data may appear as dots or shapes, connected or unconnected, and in any combination of colors and patterns. To quickly identify a data series in a chart, one can add data labels to the data points of the chart. So, the labels help us in identifying the data on the chart. The tooltip appears when tapping anywhere in the graph over a point in a series on the chart. In the mobile devices, the tool tip on the chart is very useful as the user can easily see the data represented on small screen. It should also show the name/ date and the value [6].

Edit/delete data– If the user needs to delete an entry on the chart or wants to edit it, the chart used for plotting should have the touch feature enabled. This will help the user to tap on the node to perform the operation that he wants. So there are various hurdles in choosing the right and optimal charting library for design & implementation of line charts in a hybrid application. To understand and analyze them well, below points should be looked upon:

- Same chart render in various mobile devices
- Support multi touch (zoom and pan)
- Edit/remove the data dynamically
- Legend displayed anywhere in the mobile device
- Tooltip provide more information
- Performance agnostic

In this paper a detailed analysis of charting libraries is documented to understand the challenges in achieving the best solution for our use case.

## III. Charting Libraries

### *A. Fusion Charts*

Fusion Charts [7] is an open/ paid-source of flash charting component that can be used to render data-driven animated charts. Made in Macromedia Flash MX, Fusion Charts can be used with any web scripting language like PHP, ASP, .NET, JSP, ColdFusion, JavaScript, Ruby on Rails etc. to deliver interactive and powerful charts. Using XML as its data interface, Fusion Charts makes full use of fluid beauty of Flash to create compact, interactive and visually-arresting charts. It’s payable for the commercial usage.

### *B. High Charts*

Highcharts [8] is a charting library written in pure JavaScript, offering intuitive, interactive charts to your web site or web application. Highcharts currently supports line, spline, area, areaspline, column, bar, pie, scatter, angular gauges, area range, area splinerange, columnrange and polar chart types.

### *C. Rickshaw Chart*

Rickshaw [9] is a simple framework for drawing charts of time series data on a web page, built on top of Mike Bostock's delightful D3 library. These charts can be powered by static historical data sets, or living data that continuously updates in real time. It’s a JavaScript toolkit for creating interactive time series graphs. It provides the elements to create interactive graphs: renderers, legends, hovers, range selectors, etc.

### *D. D3 Chart*

D3.js (or just D3 for Data-Driven Documents)[10] is a JavaScript library that uses digital data to drive the creation and control of dynamic and interactive graphical forms which run in web browsers. It is a tool for data visualization in W3C-compliant computing, making use of the widely implemented Scalable Vector Graphics (SVG), JavaScript, HTML5, and Cascading Style Sheets (CSS3) standards. This is not limited to drawing charts, rather can be used for creating varied styles of data visualizations.

## IV. Challenges in Choosing the Optimal Charting library for Line Chart

Depending on the requirements, following can be the benchmarks for selecting the optimum charting library:

### *A. Support for Devices, Browsers & Platforms*

Currently we’ve a broad range of devices in the market, with different software and hardware specifications. In order to fulfill the requirement set, the charting library should not only support high end mobile devices but also low end devices. It should have a common solution for different platforms (iOS, Android etc.)

### *B. Visualization of the data to be plotted*

Before starting the design of the chart, the requirements should be analyzed well to visualize a real time scenario of how & what kind of data needs to be presented. Depending on the aforementioned factor, we can pin down to the type of graph/chart that can serve our purpose best. For comparing the growth, we have used line charts as it demonstrates a board range of data plotted in a very immaculate manner.

### *C. Cost Effort & Time Effort of the Chart Library Development*

For any project, cost and time effort plays an important role to meet the deliverables with quality. Among the four charts mentioned in section 2, High Charts and Fusion Charts are paid libraries which also provide premium support. These two libraries are also easy to use but there is always a learning curve involved, since both of them have their own different APIs. These libraries come with a standard pre-defined set of graphs/charts which cater to more than 75% of the industry requirements. Other than these two paid charting libraries, we have Rickshaw and D3 which are free for commercial use. Rickshaw Charts, though relatively new, has a broad set of graph/chart and provide rich APIs as simple as High Charts and Fusion Charts. D3, instead leverages its simpler api to create requirement based graphs/charts from scratch. Although D3 needs a bit more time for implementation, it results in creation of a quality deliverable which is quite extensible.

### *D. Configurable/Customizable Legend/ToolTip*

The legend of the graph generally gets displayed on the bottom or on right side of the graph. However for small screened mobile devices, the legend may be positioned at right corner to the graph. It should be configurable and customizable. Similarly tooltip should provide more information other than ‘x’ and ‘y’ co-ordinate values.

### *E. Support for Multi-Touch, Zoom in/Zoom Out and Panning*

On the mobile devices, the features multi touch zooming and panning is on rise as the user can zoom in the chart with two finger touch and move the chart with single finger touch. The user will spend more time panning/zooming than selecting/ moving. So it makes sense to have single-finger interaction for pan, and a multi-touch pinch for zooming.

### *F. Support of the Tap Event on the Data Point to Edit/Update*

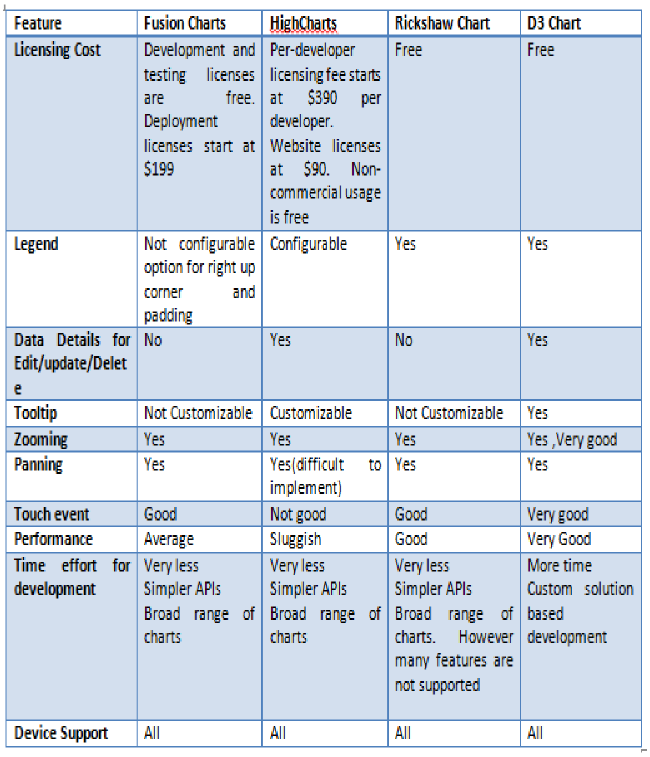
Whatever chart is planned for usage, should support the tap event on the data point, as it enable the user to drill down the data for update/delete/edit the entry on the chart.

### *G. Performance of the Chart*

The major benchmark of choosing the right charting library is “performance”. Performance feature is very important in case of mobile world, as the devices have a constraint of processing power and memory. Line chart has been chosen since it will not affect the performance of the application even in the case of low end devices. If we talk about the High Charts, Fusion charts –

though they are paid libraries and the APIs are easily available, the performance of the line charts in these two charts is not very good partially because of their support for multiple charts and other features which come bundled in the same library. So it becomes a tedious job for the user to perform any operation on the chart. Since Rickshaw is built on top of D3 its performance is at par or a bit less than D3 but that is expected as well. In D3 chart the performance is very good and in some features it outperforms the paid libraries. The touch and other features can be handled very smoothly in D3 which in turn help users to perform any operation without much hurdle. We integrated our chart application with Fusion Chart, HightCharts, Rickshaw Chart and D3 Chart. And Fig 1 below shows benchmarking of these libraries verified with above features. Fig 1 represents the benchmarking of different chart libraries.

**Fig. 1 Benchmarking**



| Feature | Fusion Charts | HighCharts | Rickshaw Chart | D3 Chart |
|---|---|---|---|---|
| Licensing Cost | Development and testing licenses are free. Deployment licenses start at $199 | Per-developer licensing fee starts at $390 per developer. Website licenses at $90. Non-commercial usage is free | Free | Free |
| Legend | Not configurable option for right up corner and padding | Configurable | Yes | Yes |
| Data Details for Edit/update/Delete | No | Yes | No | Yes |
| Tooltip | Not Customizable | Customizable | Not Customizable | Yes |
| Zooming | Yes | Yes | Yes | Yes ,Very good |
| Panning | Yes | Yes(difficult to implement) | Yes | Yes |
| Touch event | Good | Not good | Good | Very good |
| Performance | Average | Sluggish | Good | Very Good |
| Time effort for development | Very less<br>Simpler APIs<br>Broad range of charts | Very less<br>Simpler APIs<br>Broad range of charts | Very less<br>Simpler APIs<br>Broad range of charts. However many features are not supported | More time<br>Custom solution based development |
| Device Support | All | All | All | All |

## V. DECISION MAKING

Having discussed about the main challenges faced while choosing a chart library, below listed are some questions that can help in decision making:

### *A. Cost: Cost of Chart – (Paid or Free)?*

**Answer**: If you want to go for Paid chart, then High charts & Fusion charts provide a good solution. Among these two, Fusion charts provide more features. If you want to go for free charts, then you can choose from Rickshaw & D3 chart. To choose from these two charts, decide the extensibility plan for the chart you want to implement. Like, D3 chart are very extensible as you can customize the API yourselves and design & implement chart in your wished way.

### *B. Data: What Kind of Data you want to Plot on the Chart?*

**Answer**: If we talk the use case covered above, we have taken the case of lot of data to be plotted on the chart to check the growth/fall. So, if you want to check the growth of multiple items with some reference data as a bench mark, then line chart is a good option. If you want cover the statistics in whole percentage and check the area occupied by any item, then pie chart is good option. Almost all kinds of chart libraries support the line chart implementation.

### *C. Zoom: If Line Chars is Chosen, do you need Zooming/Panning Feature to get a Microscopic View of the Chart?*

**Answer**: If bulk data is plotted, in lot of charts there is a need of viewing the detailed data, the zooming/panning feature should be very good in the chart library to be chosen as it will help the user to see the detailed view on the small mobile screen very effectively. All the charts described above have these features. But in our implementation, we found it is very good in D3 chart.

## VI. RELATED WORK AND MOTIVATION

A lot of research work has been carried out in the field of data visualization. Author in [1] proposes the approach for the visual design and author in [2], [4] and [5] discuss various chart types and help to choose the right one. Author in [3] proposes different visualization techniques to adopt. Author in [6] discusses about the visualization of data on movement of mouse. The different types of charts like Fusion chart, HighChart, Rickshaw and D3 chart are discussed with implementation guidelines in [7],[8],[9] and [10]. The topic under study in this paper is unique in its focused research in area of data visualization using chart libraries on mobile devices.

## VII. CONCLUSION AND FUTURE WORK

There is lot of factors needed to be considered for choosing a charting library specific to render line chart in hybrid mobile applications. In small screened devices, the data representation using line chart should support zoom, pan and touch features. During benchmarking, we compared HighChart, Fusion, Rickshaw and D3 chart libraries in Android and iOS devices like Samsung S4, Samsung S3, Samsung Galaxy Tab 4, iPhone 4S, iPhone 5 and iPad. Fusion and Rickshaw chart fail to provide all the features in Line chart and High-Chart is cost effective. Though implementing Line chart is complex using D3 chart library, the performance of D3 chart is better than others and it is open source. In decision making, we conclude that depending on the requirements of the chart, one should evaluate well all kinds of charting libraries and choose according to the preferences in implementation and not just cost & time factors. In the future, a mobile D3 Chart SDK could be built to provide simplified and flexible D3 interface for mobile application developers.

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