



IBM Bluemix

Comparative Evaluation

Andre Siagian · Lavanya Kumar · Lu Huang · Michael Nguyen

Table of Contents

I.	Table of Contents	1
II.	Executive Summary	2
III.	Introduction	4
IV.	Methods	5
V.	Findings and Recommendations	6
	Documentation.....	6
	Target Segment.....	12
	Wizard User Interface.....	13
	Security.....	14
	Cloud Dimensions	18
	Database	19
VI.	Discussion	21
VII.	Conclusion	22
VIII.	References	22
IX.	Appendices: Comparison Metrics Tables	23
	Usability Analysis	23
	Feature Analysis	25
	Business Offering Analysis.....	26
	Security Analysis.....	27

Executive Summary

This report illustrates a comparative analysis that was conducted between IBM Bluemix and several of its competitors: Amazon Web Services, Microsoft Azure, Heroku, Oracle Cloud, and Google App Engine. As IBM Bluemix is a Platform as a Service, we decided to compare it to other PaaS brands that allowed for application creation and service customization. We rated each of these competitors across several dimensions on a numeric scale as well as with Yes (“Y”) and No (“N”) indicators. The numeric metric indicators had to do with the specific dimensions that were being described (e.g. for “interface design” and “usability” metrics, 1 indicated a serious issue that needed attention while a 5 represented a well designed and implemented feature). To expand on our matrix table, we compared each service based on cloud dimensions, storage, interface design, usability of wizard assistance, integration, security, documentation, business requirements, platform services, and programming language support.

This research led to the following findings and recommendations:

- **Documentations**

- **Finding** - Documentation is not Search Engine Friendly
- **Finding** - Intuitiveness of Navigation Architecture
- **Finding** - Use of Visual Aids
- **Finding** - Freedom of Movement within Documentation Page
- **Recommendation** - Bluemix should make its documentation easily searchable and there should be breadcrumbs to make the user interface and application creation process easier to navigate.

- **Target Customers**

- **Finding** - Bluemix is Cost-Efficient to Cater to a High Volume of Users
- **Finding** - Bluemix has Competitive Features and Cross-Selling Opportunities
- **Finding** - Bluemix is a Recognized Enterprise Service Provider
- **Recommendation** - IBM has a strong reputation and Bluemix should leverage that and focus on establishing dominance in the enterprise market.

- **Identification and Authentication**

- **Recommendation** - IBM Bluemix could use a two-factor authentication system to add a protection layer of security to users’ accounts when users first register on Bluemix

- **Online Auditing and Security Awareness Training**

- **Recommendation** - IBM Bluemix needs to take online auditing into consideration, or develop online auditing as a plug-in or app to the cloud service

- **Incident/ Disaster Recovery**

- **Recommendation** - IBM Bluemix needs to be more transparent in displaying maintenance and disaster recovery processes.

- **Cloud Dimensions**
 - **Recommendation** - IBM Bluemix should make it easy for these companies to pick and choose (a la carte) certain PaaS features and services.
- **Variety of Database Usage**
 - **Recommendation** - It is great that Bluemix integrates Cloudant with their services, and they should continue to do so since it is a newer database system and will likely be adopted for larger-scale products.
- **Wizard User Interface**
 - **Recommendation** - Bluemix needs a clear and concise image or page stating that the application has been created.

Introduction

This assignment asked us to perform a comparative analysis between IBM Bluemix and its competitors. We started by researching the current market for vendors offering PaaS products and ended up with a shortlist of five other companies - all of which were intentionally different in market share and service offerings, but equally compelling in nature.

We chose:

- AWS Elastic Beanstalk
- Microsoft Azure
- Heroku (Salesforce)
- Oracle Cloud
- Google App Engine

Through a systemic and layered evaluation process, we performed our analysis in a way that would highlight key differences (and similarities) between these companies' products and Bluemix. This was so that our findings could lead to solid, evidenced-based recommendations for Bluemix that would notify them of products, services, and other offerings previously unbeknownst to them. Ultimately, we intend for Bluemix to read our analysis so they can understand their strongpoints, their areas of improvement (and the urgency of these areas), and how their competitors are addressing (or have addressed) similar problems.

Methods

Our comparative analysis helped us identify Bluemix’s competition, its users’ likely expectations, and where its users have succeeded and failed. In addition, it highlighted best practices, solutions to challenging issues, and strong feature implementations for its website.

Competing Services

To identify competing services, we primarily used input from our online survey based on services that potential users of Bluemix would use. We also used Google to search for keywords such as “Cloud Service” and “PaaS” to expand or filter our list. Finally, we searched the market shares of these potential competitors to set priorities and categorize them. We sorted the list of competitors based on the following types:

Director Competitors	Offer same service and target at same users as IBM Bluemix, e.g. AWS, Heroku
Indirect Competitors	Offer same service but target a different users as IBM Bluemix, e.g. Microsoft Azure, Oracle Cloud
Partial Competitors	Offer some but not all services and target some but not all users as IBM Bluemix, e.g. Google App Engine

Identification of Dimensions

Our selection of competitors was based on the nature of Bluemix as a Cloud platform and a Platform as a Service software. Given that IBM Bluemix competitors vary in degree of similitude, we selected metrics that represented different types of customers and their diverse demands (Appendix).

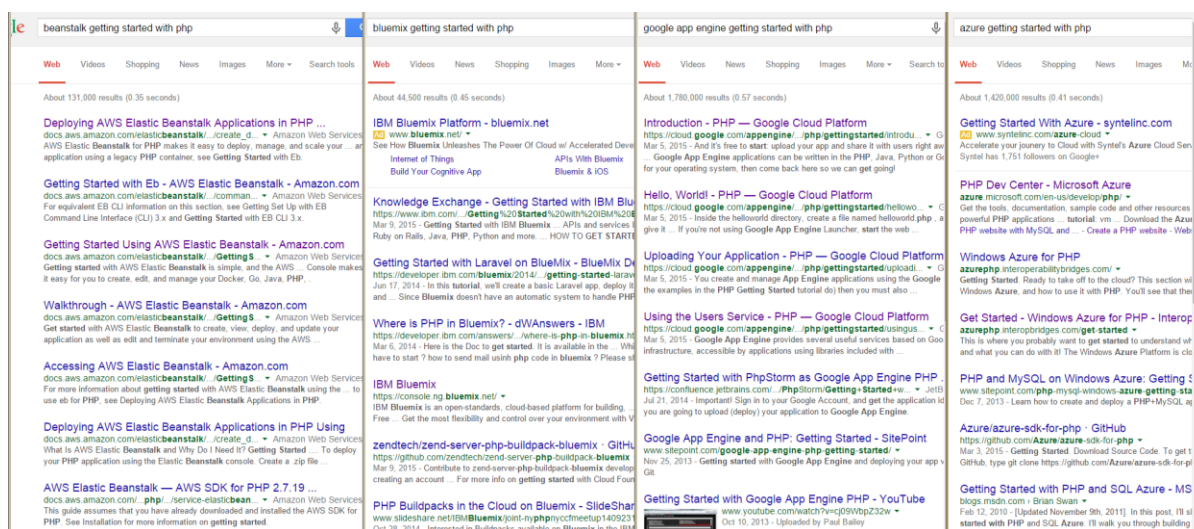
After selecting competitors and finalizing our dimensions and their respective metrics, we examined each competitor’s websites and services according to several higher level dimensions: cloud dimensions, storage, interface design, usability of wizard assistance, integration, security, documentation, business requirements, platform services, and programming language support. These dimensions were abstracted from our survey interpretations as well as from various online PaaS reports (References). After our examinations we had an interpretation session where we debriefed and integrated the evaluations into a matrix table (Appendix).

Findings and Recommendations

Documentation

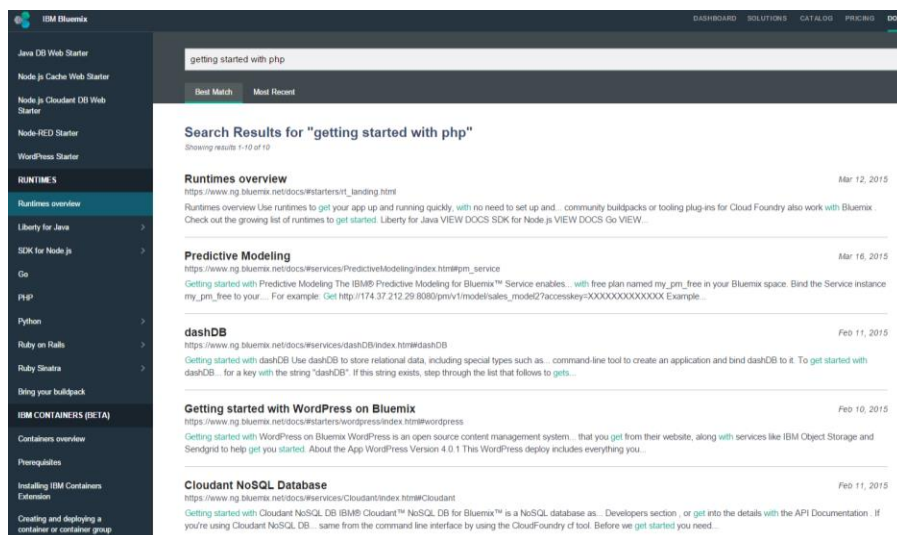
Finding 1: Documentation is not Search Engine Friendly

Our comparative testing of Bluemix and its competitors indicate that Bluemix's documentation is less search engine friendly compared to its competitors. A Google search of "Getting started with PHP" relative to each of our competitors (Azure, Beanstalk, Google App Engine) resulted in links to the appropriate documentation pages shown in the first few search results. However, it was much more difficult to search for Bluemix's documentation.



Comparative Search Engine Results for "Getting Started with PHP"

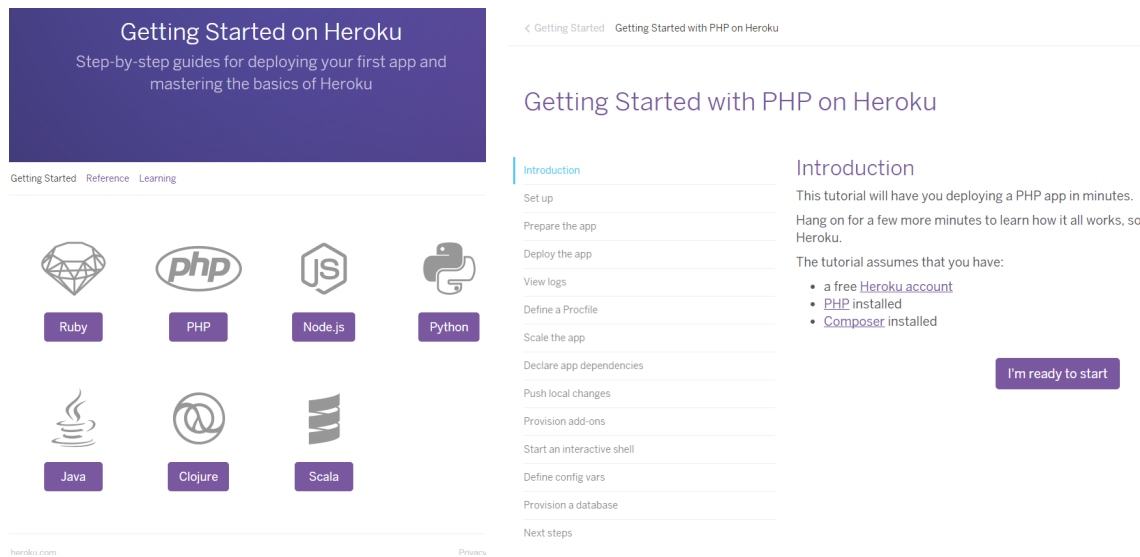
Bluemix also falls short relative to its competitors in terms of documentation search (specifically when using an internal search engine). Search results on Bluemix's search engine did not immediately show links to appropriate "getting started" documentation.



Bluemix's Search Results for "Getting Started with PHP"

Finding 2: Intuitiveness of Navigation Architecture

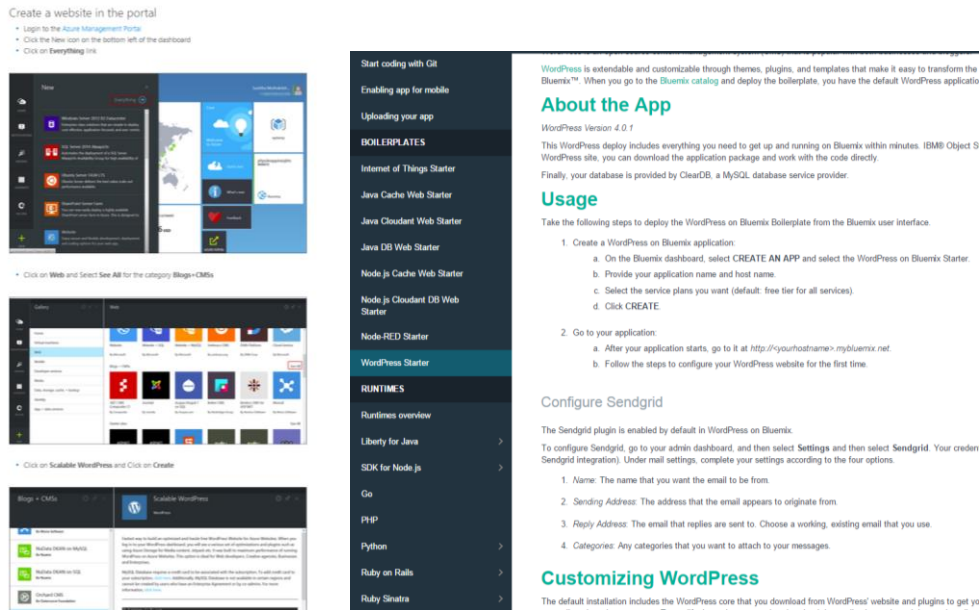
Information architecture is key to navigability and intuitive user experience of documentation. Heroku stands out in its presentation of documentation. For instance, it uses visual aids and groups its “Getting Started” documentation based on supported programming languages. Furthermore, Heroku divides its information by stages of the development process, which is very easy to follow, as all relevant information is easily accessible. In contrast, Bluemix’s navigation bar is cluttered and overwhelming, and the information breakdown, although understandable, is not easy to browse through.



Heroku's Documentations

Finding 3 – Use of Visual Aids

Microsoft Azure consistently uses intuitive visual aids, especially during the process of creating a WordPress site. Bluemix, Google App Engine, and Amazon use very few visual aids and the documentation is text-heavy and somewhat overwhelming.

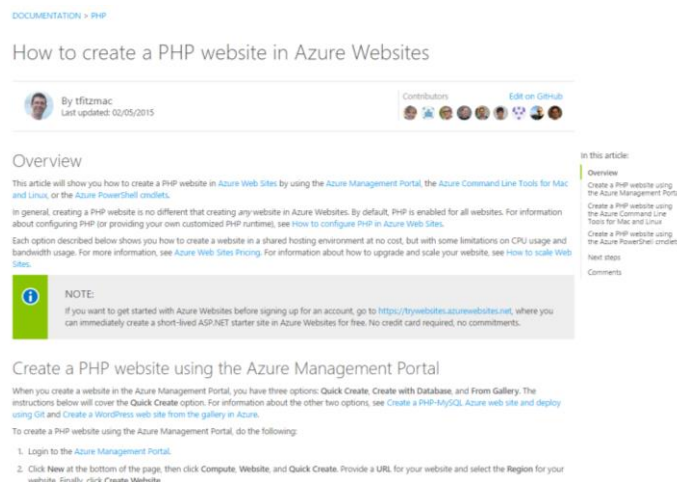


Azure Wordpress Docs

Bluemix Wordpress Docs

Finding 4 – Freedom of Movement within Documentation Page

Heroku, Azure, and Google App Engine aid a user's freedom of movement via their documentation pages by providing *breadcrumbs* and a special side navigation bar for browsing. Bluemix does not provide a way for users to easily browse through segments of a documentation page, forcing users to scroll up and down to find the specific information they need.



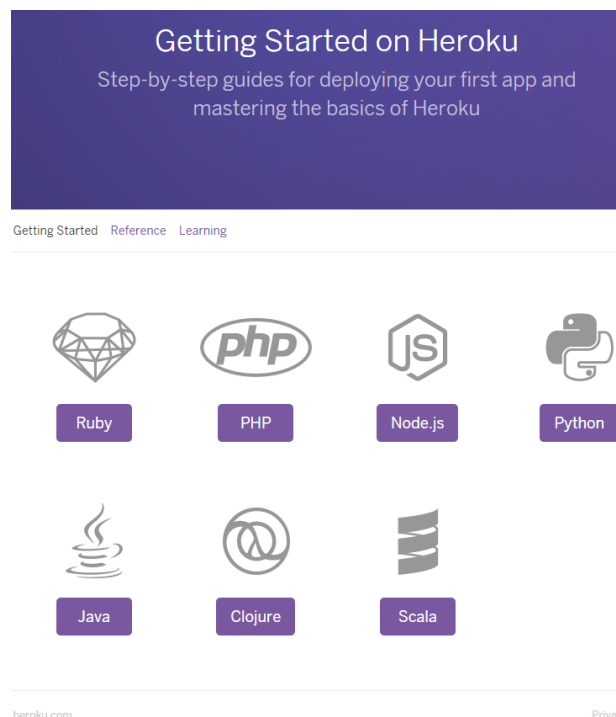
Microsoft Azure's "How to Create a PHP Website in Azure Websites" Documentation

Recommendations

Bluemix should combine the best documentation practices shown by its competitors.

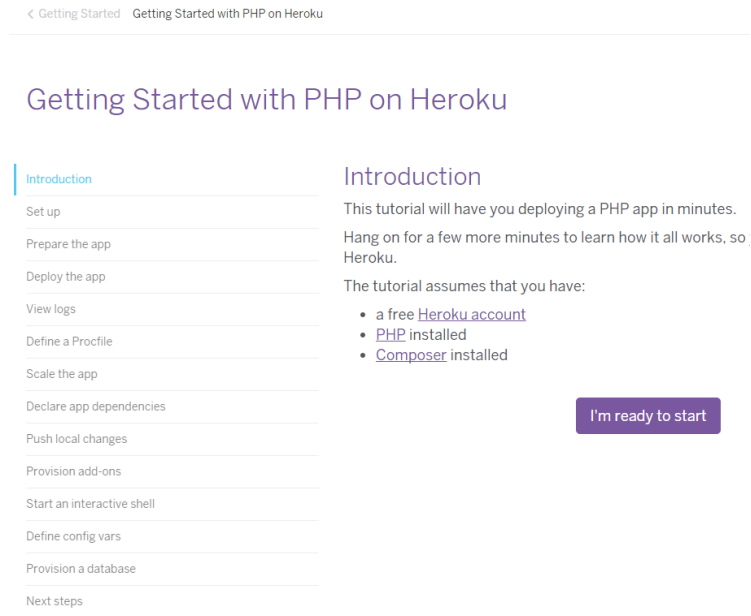
First, Bluemix should make its documentations easily searchable both on external and internal website search engines. Our surveys indicated that developers most often go to Google when searching for appropriate documentation. Bluemix should be aware of the common terms used when searching for certain types of documentation, and it should employ SEO principles to ensure that documentations appear as the first results of popular search engines (i.e. Google, Bing, Yahoo). The website's search engine should also immediately display relevant results.

Second, Bluemix should follow Heroku's example in making their documentation's information architecture more usable and intuitive. This can be done by grouping documentation topics with visible visual aids and using terms that are easily recognized by users from diverse backgrounds.



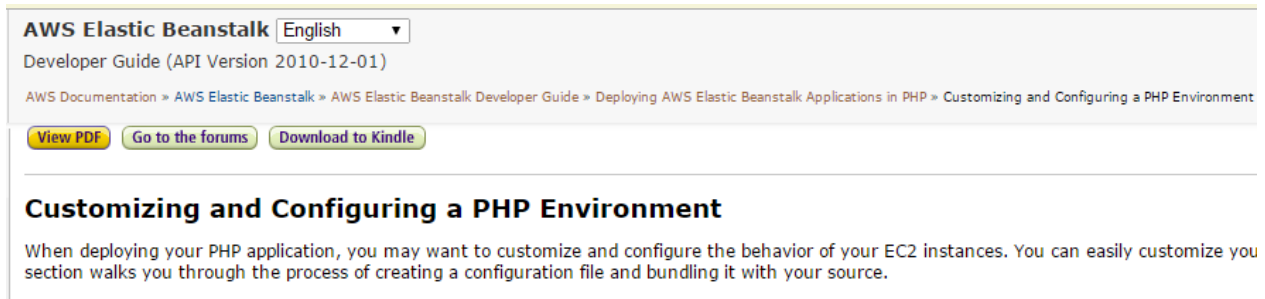
Heroku's "Getting Started on Heroku" Documentation

Third, Bluemix should follow Heroku’s breakdown of documentation “subtopics” (e.g. getting started with PHP on Heroku), by providing all relevant information on that topic in a comprehensive manner and while dividing the information based on the order of process stages. This way, users can easily navigate between different stages and recognize their location and needs.



Heroku’s “Getting Started with PHP” Documentation

Fourth, within each documentation page, there should be *breadcrumbs* to help users find relevant information and give them freedom to move around within similar search topics.



AWS Elastic Beanstalk’s PHP Documentation

Fifth, a side navigation bar with links to a documentation page’s subtopics will help users navigate through the page more easily and efficiently. This in-page side navigation bar should be “fixed” on the screen so users do not have to scroll back up to see the division of the page.

Microsoft Azure

SALES 1-800-867-1389 MY ACCOUNT PORTAL Search

Features Pricing Documentation Downloads Marketplace Blog Community Support FREE TRIAL

Note that you can execute the `azurerm site create` command with any of the following options:

- `--location [location name]`. This option allows you to specify the location of the data center in which your website is created (e.g. "West US"). If you omit this option, you will be prompted to choose a location.
- `--hostname [custom host name]`. This option allows you to specify a custom hostname for your website.
- `--git`. This option allows you to use git to publish to your website by creating git repositories in both your local application directory and in your website's data center. Note that if your local folder is already a git repository, the command will add a new remote to the existing repository, pointing to the repository in your website's data center.

For information about additional options, see [How to create and manage an Azure Web Site](#).

Create a PHP website using the Azure PowerShell cmdlets

To create a PHP website using the Azure PowerShell cmdlets, do the following:

- Install the Azure PowerShell cmdlets by following the instructions here: [Get started with Azure PowerShell](#).
- Download and import your publish settings file by following the instructions here: [How to: Import publish settings](#).
- Open a PowerShell command prompt and execute the following command:

```
New-AzureWebSite MySiteName
```

The URL for the newly created website will be `http://MySiteName.azurewebsites.net`.

Note that you can execute the `New-AzureWebSite` command with any of the following options:

- `-Location [location name]`. This option allows you to specify the location of the data center in which your website is created (e.g. "West US"). If you omit this option, you will be prompted to choose a location.
- `-Hostname [custom host name]`. This option allows you to specify a custom hostname for your website.
- `-Git`. This option allows you to use git to publish to your website by creating git repositories in both your local application directory and in your website's data center. Note that if your local folder is already a git repository, the command will add a new remote to the existing repository, pointing to the repository in your website's data center.

For information about additional options, see [How to: Create and manage an Azure Web Site](#).

Next steps

Now that you have created a PHP website in Azure Websites, you can manage, configure, monitor, deploy to, and scale your site. For more information, see the following links:

- [How to configure Web Sites](#)
- [How to configure PHP in Azure Web Sites](#)

In this article:

- Overview
- Create a PHP website using the Azure Management Portal
- Create a PHP website using the Azure Command Line Tools for Mac and Linux
- Create a PHP website using the Azure PowerShell cmdlets
- Next steps
- Comments

Microsoft Azure’s PHP Documentation

Finally, Bluemix should provide visual aids to its users. For instance, when showing the process of setting up a certain programming language environment, graphics that depict each step will be really useful. This will improve understandability of the process, make the documentation less overwhelming for users, and help users who are not familiar with the features and architecture of Bluemix.

Severity: High

Ease of Implementation: Medium

Best Practice Example: Heroku (information architecture), Microsoft Azure (in-page)

Target Segment

Finding 1 – Bluemix is Cost-Efficient for Bluemix High # of Visitors & High GET Request

Based on calculations of general cost of adoption, Bluemix is relatively competitive for clients who are developing applications with large numbers of users and activities. Bluemix charges no extra cost for GET and PUT requests unlike the market leader Amazon Web Services. However, it is important to note that Microsoft Azure is still more competitive in infrastructure cost-of-adoption both for larger projects and across the board. This analysis does not take into account what Bluemix and other competitors charge for add-on services.

Finding 2 – Bluemix has Competitive Features & Cross-selling Opportunities

Bluemix ranks highest in cross-selling opportunities because IBM has plenty of complementary services that are only available to IBM customers, such as Watson plugins. It also has a large pool of loyal business customers, as existing IBM customers use services or products from other IBM divisions. Finally, IBM's unique offering for integration between IBM's services and a client's in-house applications would serve as a competitive selling proposition.

Finding 3 – Bluemix is a Recognized Enterprise Service Provider

Gartner's research about Enterprise Platform-as-a-Service vendors indicates that IBM is the segment leader trusted for delivering IT services to businesses wanting scalability and performance reliability.

Recommendations

Given cross-selling opportunities and unique service offerings, as well as recognition as the trusted leader of enterprise IT service providers, IBM should focus on consolidating its position as the preferred PaaS choice for enterprise users, starting by securing existing IBM users. From a software infrastructure standpoint, IBM's cost of adoption is also more competitive for larger development projects. Furthermore, IBM has a lack of recognition as a consumer cloud service / PaaS provider relative to Amazon, Google, Heroku (SalesForce), and Microsoft. Therefore, it is more profitable and efficient to focus on establishing dominance in the enterprise market, especially with customers that could potentially adopt other IBM services.

In practice, Bluemix should ensure that it should only release updates after iterations of system reliability and scalability testing, which are critical to enterprise customers. Beta & experimental features should only be released to a limited pool of users.

Severity: High

Ease of Implementation: Hard

Best Practice Example: Microsoft Azure (cost-efficient)

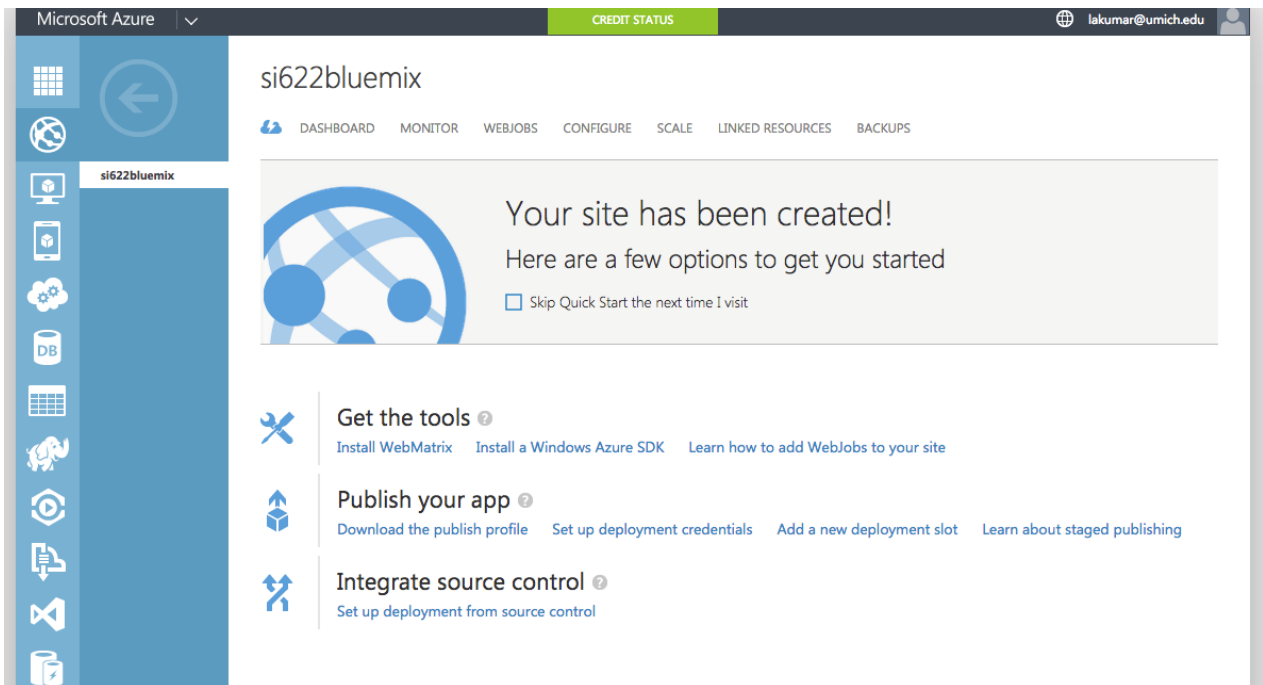
Wizard User Interface

Finding

Bluemix needs to provide a better confirmation when a user creates an application. Also, it is a little confusing to know where to go once the app has been created (if it has even been developed successfully).

Recommendation

Microsoft Azure has a clear and concise image stating that the application has been created. They also give various other options, as not to create a “dead end” or “what now?” Bluemix says that the application is “staging,” and as a user, we don’t really know what that means and what we can do in the meantime. As a means of stronger user feedback, perhaps Bluemix should include a countdown or time estimate so that the user can gauge how long it will take to set up certain kinds and sizes of servers, apps, etc.



Microsoft Azure’s Wizard

Severity: High

Ease of Implementation: Easy

Best Practice Example: Microsoft Azure

Security

Finding 1 – Incident Recovery (or Disaster Recovery)

In comparison to early stage competitors, IBM Bluemix lacks a firm definition on incident procedures and policies. Meanwhile, Amazon Web Services has a storage gateway for rapid disaster recovery, Microsoft Azure and Heroku offer diagnostics, and Google App Engine regularly monitors user patterns. Google App Engine also offers regular security maintenance scans. Despite what the competition offers, IBM Bluemix documentation states “IBM does not continue to maintain the servers. You must maintain them in accordance... the BigInsights service on IBM Bluemix, you can plan for and request a new cluster for your enterprise on IBM SoftLayer” [3].

Security (FedRAMP standards)		IBM Bluemix	Amazon Web Services	Microsoft Azure	Heroku	Oracle Cloud	Google App Engine
Incident Response Policy and Procedures	no report of disaster report	5 Amazon EC2, AWS Storage Gateway Service for rapid disaster recovery	5 Enable Diagnostics in Azure Cloud Service	5 Heroku Status provides the current status and incident history report for the Heroku platform.	3 Managing diagnostic data	4 Software Architecture work: Document your routine backup, regular maintenance, and disaster recovery processes.	

IBM Bluemix

Score: 1 – No known disaster report.

AWS Elastic Beanstalk

Score: 5 – AWS Storage Gateway Service for rapid disaster recovery.

Google App Engine

Score: 4 – Software architecture work; documents user’s routine backup, regular maintenance, and disaster recovery processes.

Oracle Cloud

Score: 3 – Manages diagnostic data.

Microsoft Azure

Score: 5 – Enables diagnostics in Azure Cloud Service.

Heroku

Score: 5 – Heroku provides the current status and incident history report for the Heroku platform.

Recommendation

While users care about incident response, it's unclear for users when they search on the documentation to find out whether Bluemix has regular maintenance and disaster recovery processes. Two possible reasons are: either Bluemix hasn't included disaster recovery in its documentation, or disaster recovery is still under construction. Whatever the reason, it's important to show users, for example technical managers, who is going to make purchase decisions and that Bluemix has strong and solid solutions to protect users' data and full solution to solve unexpected disaster.

Severity: High

Ease of Implementation: Hard

Best Practice Example: Amazon Web Service, Google App Engine

Finding 2 – Identification and Authentication

IBM Bluemix doesn't have an established authentication system and documentation, as developers need to configure the authentication mechanism by using a token. Amazon Web Service, Microsoft Azure and Google App Engine all use well-developed authentication systems.

IBM Bluemix

Score: 3 – A helper method to set the user identification received from security; identification received from security provider.

AWS Elastic Beanstalk

Score: 5 – Cloud formation authentication.

Google App Engine

Score: 5 – Google APIs support OAuth assertions to identify the source of the request.

Oracle Cloud

Score: 3 – You can configure the authentication mechanism to use by setting element ... authentication, a child of element httpconfig, in configuration file.

Microsoft Azure

Score: 3 – Multi-factor Authentication documentation.

Heroku

Score: 5 – Use easy search to tag and filter important events for immediate issue identification; Two-factor authentication adds an extra layer of security to your Heroku account.

Recommendation

In terms of identification and authentication, IBM Bluemix could use a two-factor authentication system to add a protection layer of security to users' accounts when users first register on Bluemix. For example, Bluemix can verify an account or identity through use of SMS confirmations. Bluemix can also set up recovery options when users are locked out or forget their account ID. For example, when users change their phone numbers, they should have the option to change the mobile devices that are connected with their accounts. Finally, IBM Bluemix should also give users some options to disable authentication, especially in cases of organizational change (i.e. when developers or managers quit their jobs and no longer need access to Bluemix).

Severity: High

Ease of Implementation: Easy

Best Practice Example: Heroku

Finding 3 – Online auditing and security awareness training

IBM Bluemix and Google App Engine do not support online auditing in cloud services, while Amazon Web Service, Oracle Cloud, and Heroku do support this function.

Recommendation

IBM Bluemix needs to take online auditing into consideration, and develop it as a plug-in or app to the cloud service. Based on CSA guidelines (Control Self-Assessment), there are five security and control issues regarding online auditing in PaaS: key risk issues, key governance issues, key security concerns, control requirements with focus on CSA, and cloud security alliance requirement. To utilize these functions, IBM Bluemix can look into ISACA Maryland Chapter to audit tools and techniques: user of SOC (Service Organization Control) reports and some examples of audit programs. IBM Bluemix as a PaaS can significantly improve the enterprise data quality in accounting because Bluemix generates more transparent and statistically reliable data.

Severity: Medium

Ease of Implementation: Medium

Best Practice Example: AWS Elastic Beanstalk, Heroku

Cloud Dimensions

Finding

Many medium and large-scale companies investing in cloud services are hesitant to consider and adopt public cloud services, as they currently favor private cloud services. These companies report a high need for security, compliance, and protecting client data. As such, private cloud services can provide the utmost customization but also come with a hefty price tag (Gartner research paper on Public, Private, Hybrid PaaS).

Recommendation

Based on the current innovation and adaptability scores of public cloud services, we believe that many sizable, existing companies using private cloud will gradually shift towards public cloud. We realize that such a transition would be a layered process, met with opposition from different departments and voices within the company. Therefore, Bluemix should make it easy for these companies to pick and choose (a la carte) certain PaaS features and services. For example, maybe a company needs only one or two servers but needs many gigabytes of memory from Bluemix at one time. Meanwhile, the company continues using its own servers for its highly sensitive transactions. There should be a package that addresses this scenario, which IT professionals refer to as “hybrid cloud.”

Severity: Low

Ease of Implementation: Medium

Best Practice Example: Google App Engine, AWS Elastic Beanstalk

Database

Finding

All PaaS services support many of the main types of databases. These include Relational, Key-Value NoSQL, and Document-Style NoSQL database management systems [1].

In fact, many of these software use IBM's own Cloudant as their NoSQL Document-style database (e.g. Heroku) [2]. Bluemix uses SQL Database as a relational database, MongoDB for key-value database management, and IBM's very own Cloudant for NoSQL Document-style database management (however, these options are not exclusive).

The screenshot shows the IBM Cloudant services page. On the left is a navigation menu with categories like Watson, Mobile, DevOps, and Support. The main content area is titled 'Data Management' and lists several database services in a grid:

- Cloudant NoSQL DB (IBM)
- DataWorks (IBM)
- Object Storage (IBM BETA)
- Object Storage (v2) (IBM BETA)
- SQL Database (IBM)
- ClearDB MySQL Datab... (Third Party)
- ElephantSQL (Third Party)
- MongoLab (Third Party)
- Redis Cloud (Third Party)
- mongodb (Experimental)
- mysql (Experimental)
- postgresql (Experimental)
- Probabilistic Match (Experimental)

The screenshot shows the Oracle website banner for 'Oracle Industry Connect'. The banner features a collage of images related to industry events and business. The main text reads: 'GET READY FOR ORACLE INDUSTRY CONNECT'. Below this, it says: 'Learn best practices and groundbreaking strategies to help modernize your business and stand out against the competition. Coming to Washington, DC, March 25-26.' There is a 'See the agenda' button and two links: 'Mark Hurd's keynote at Oracle Industry Connect 2014' and 'Oracle Industries: Living and breathing your industry every day'.

Recommendation

NoSQL document-based database management services are much easier to work with as they are more readable and accessible to humans, are flexible, and also very scalable. It is great that Bluemix integrates Cloudant with their services since it is a newer database system and will likely be adopted for larger-scale products. They should continue to maintain their relationship with SQL Databases for those who are used to the DBMS and want to create projects on a smaller scale. One suggestion could be for Bluemix to categorize or suggest their database types based on the user's described project. There could be a secondary filter that suggests which database would be most suitable for their project scale and deliverables. A prime example of this is in Oracle's Cloud Software where they ask the user about their background and project in order to provide suggestions on services.

Severity: Low

Ease of Implementation: Medium

Best Practice Example: Oracle Cloud

Discussion

Overall, the competitors' products offered an insightful range of features that users care about when creating an application. Among our dimensions, we found that Bluemix was advantageous in its database options but needed to improve its wizard user interface, security, and business requirements among other metrics.

To make our research more complete, the following considerations would have been beneficial:

1. Comparison between websites with more diverse user groups of different ages and geographic backgrounds.

Amazon Web Service, Oracle Cloud, Microsoft Azure and Google App Engine have a variety of users located in different states or countries. Because countries have different regulations and governance requirements, these documentation of these competitors emphasize diverse demands. For example, in terms of security, Microsoft Azure and Amazon Web Service put more emphasize on FedRAMP regulation in their documentations, while Google App Engine does not. Therefore, when evaluating websites, we need to wary of which of our competitors' features are comparable with Bluemix.

2. Comparison with websites focused on developers and technical managers.

As the primary users of Bluemix are developers and managers, it's important to think as developers and technical managers. This involves knowing what features they are looking for as well as the pattern of their search behaviors. We drew these features from our survey, interviews, and Google Search, so there may be a bias in feature selection due to sample size.

By considering these recommendations, Bluemix will be able to start a simple yet effective feature set most applicable to its users.

Conclusion

Comparing various PaaS software has been beneficial in determining the strengths and weaknesses of IBM Bluemix. While some key findings encourage Bluemix to maintain its practices in order to compete with similar services, many findings and recommendations offer methods of improvement for Bluemix (through its wizard user interface, security, or business requirements). These recommendations are also meant to serve as a starting point for further research on other aspects of Bluemix, using the above competitors as a basis.

References

1. Feinberg, Donald, and Lakshmi Randall. *Market Guide for Database Platform as a Service*. Rep. no. G00261719. Gartner, n.d. Web. 15 Mar. 2015.
2. "Heroku Accelerates NoSQL Cloud Development with Four New Add-ons." Heroku | News. Heroku, 20 July 2010. Web. 15 Mar. 2015.
3. Natis, et al. *Platform as a Service: Definition, Taxonomy, and Vendor Landscape*. Gartner, n.d. Web. 15 Mar. 2015.
4. Natis, et al. *Magic Quadrant for Enterprise Application Platform as a Service*. Gartner, n.d. Web. 15 Mar. 2015.
5. Natis, et al. Natis, Yefim. *Gartner Research Highlights Platform as a Service*. Gartner, n.d. Web. 15 Mar. 2015.
6. Natis, et al. *Predicts 2015: Private, Public, and Hybrid: PaaS Advances*. Gartner, n.d. Web. 15 Mar. 2015.
7. Natis, et al. *Predicts 2015: Gartner Reference Model for PaaS*. Gartner, n.d. Web. 15 Mar. 2015.
8. Guttridge, Keith, et al. *Predicts 2015: Market Guide for Integration Platform as a Service*. Gartner, n.d. Web. 15 Mar. 2015.
9. Various pages and documentations for Heroku, AWS Elastic Beanstalk, Oracle Cloud, Microsoft Azure, and Google App Engine

Appendices: Comparison Metrics Tables

Usability Analysis						
Interface Design	IBM Bluemix	AWS Elastic Beanstalk	Google App Engine	Oracle Cloud	Microsoft Azure	Heroku
Color Scheme	4	5	5	5	5	3
Font Size and Type	4	5	4	4	4	4
Consistency Across Pages (UI)	3	5	5	3	4	5
Wording of Content	3	3	4	3	4	4
Visual Organization of Information	2	4	4	2	4	5
Average:	3.2	4.4	4.4	3.4	4.2	4.2
Wizard Assistance Usability	IBM Bluemix	AWS Elastic Beanstalk	Google App Engine	Oracle Cloud	Microsoft Azure	Heroku
Helpfulness	3	4	5	4	4	4
Limiting Redundancy	4	5	5	4	4	5
Speed (e.g. creating the application, between steps)	2	4	3	4	5	4
Navigability (e.g. breadcrumbs)	3	3	4	5	5	4
Access	2	5	3	4	5	3
User Choice (opt-in / opt-out)	3	5	5	3	4	4
Wizard Content	3	4	4	4	3	3
Intuitiveness	2	4	5	4	4	3
Ease	3	4	5	4	4	3
Average:	2.8	4.2	4.3	4.0	4.2	3.7
Documentations Usability	IBM Bluemix	AWS Elastic Beanstalk	Google App Engine	Oracle Cloud	Microsoft Azure	Heroku
Active Developers Community & Forums	4	5	5	2	5	3
Search						
Searchability with Website's Navigation	4	4	3	3	3	5
Organization of Documentation Section	3	3	3	2	4	5
Searchability with Website's Search Engine	1	5	5	2	3	5
Searchability with Google Search Engine	1	5	5	1	3	5
Ease of Finding Desired Information	4	4	3	1	4	5
General Search Time	4	4	3	1	4	5
Content						
Helpful Visual Aids	3	3	3	2	5	3
Reachability of Relevant Information	2	4	5	2	5	5
Intuitiveness of Information Breakdown	3	4	5	5	5	5
Usefulness of Displayed Information	5	3	5	3	5	5
Understandability of Information	5	4	5	4	5	5
Not Overwhelming	4	2	2	1	5	5
Average:	3.3	3.8	4.0	2.2	4.3	4.7
Usability for WordPress Development	IBM Bluemix	AWS Elastic Beanstalk	Google App Engine	Oracle Cloud	Microsoft Azure	Heroku
WordPress Site Hosting	Y	Y	Y	N	Y	Y

MySQL Database	Y	Y	Y	N/A	Y	Y
PHP Support	Y	Y	Y	N/A	Y	Y
Guidance / Wizard for Wordpress Creation	Y	N	N	N/A	Y	N
Storage for Wordpress Content Library	Y	Y	Y	N/A	Y	N
Supporting Plugins for Wordpress	Y	Y	Y	N/A	Y	N
Documentation specifically for Hosting WordPress (1: Not at all intuitive and helpful - 5: extremely intuitive and helpful)	3 (easy to follow, comprehensive, slightly inaccurate, N visual aid)	2 (eNugh visual aid, Nt easy to follow, complicated)	4 (short, easy to follow, N visual aid)	N/A	5 (easy to follow, excellent visual aid, intuitive, comprehensive)	N/A, Third-party only
Ease of Set Up for Wordpress Site (1: Not at all easy - 5: extremely easy)	4	1	2	N/A	5	1
Customizability, Performance, Integration, and Scalability for WordPress (1: worst - 5: best)	4 (scalable, highly customizable, variety of add-on services, smooth integration)	3 (scalable, some WordPress-friendly plugins, moderate customization)	2 (scalable, lack customization & performance add-ons)	N/A	5 (scalable, highly customizable, variety of performance plugins <i>specific for WordPress</i> , smooth integration)	1 (Moderately scalable, Nt customizable, N WordPress plugin)

Feature Analysis						
Cloud Dimensions	IBM Bluemix	AWS Elastic Beanstalk	Google App Engine	Oracle Cloud	Microsoft Azure	Heroku
Private Sharing	Y	Y	Y	Y	Y	N
Public Sharing	Y	Y	Y	Y	Y	Y
Hybrid Sharing	Y	Y	Y	N	Y	Y
Internal Responsibility	Y	Y	Y	Y	Y	Y
External Responsibility	N	N	N	N	N	N
Supported Programming Languages	IBM Bluemix	AWS Elastic Beanstalk	Google App Engine	Oracle Cloud	Microsoft Azure	Heroku
Clojure	Y	N	Deployment	N	N	Y
Go	Y	Deployment	Y	N	N	Deployment
Java	Y	Y	Y	Y	Y	Y
JavaScript	Y	Y	Y	Y	Y	Y
.Net (Windows)	N	Y	N	N	Y	N
PHP	Y	Y	Y	N	Y	Y
Python	Y	Y	Y	N	Y	Y
Ruby	Y (Rails & Sinatra)	Y (Rails & Sinatra)	Y (JRuby)	Y (JRuby)	Y (Rails)	Y (Rails & Sinatra)
Scala	N	Deployment	Deployment	N	N	Y
Features	IBM Bluemix	AWS Elastic Beanstalk	Google App Engine	Oracle Cloud	Microsoft Azure	Heroku
Analytics						
Application Analytics	Y	Y	Y	Y	Y	Y
Business Intelligence	Y	Y	Y	Y	Y	Y
Database Analytics	Y	Y	Y	Y	Y	Y
Mobile Analytics	Y	Y	Y	Y	Y	Y
Predictive Analytics	Y	Y	Y	Y	Y	N
Big Data Processor	Y	Y	Y	Y	Y	Y
Development & Operations						
Tracking & Planning	Y	Y	Y	N	Y	Y
Business Rules / Process Automation	Y	N	Y	Y	Y	N
Scheduler	Y	Y	Y	N	Y	Y
Scalable Development	Y	Y	Y	Y	Y	Y
iOS Development	Y	Y	Y	N	Y	Y
Android Development	Y	Y	Y	N	Y	N
Email Delivery	Y	Y	Y	N	Y	Y
Integration Services						
Cloud Integration	Y	Y	Y	Y	Y	Y
Enterprise System Integration	Y	Y	Y	Y	Y	Y
API Management	Y	Y	Y	Y	Y	Limited
Data Management						
Storage Capacity	2	3	3	4	5	4
Relational DBMS	Y	Y	Y	N	N	Y
Key-Value NoSQL DBMS	Y	Y	Y	Y	Y	Y
Document-Style NoSQL DBMS	Y	Y	Y	Y	Y	Y
Database Cache	Y	Y	Y	Y	Y	Y
Object Storage	Y	Y	Y	Y	Y	N
Security Service	Y	Y	Y	Y	Y	Y
Integration Capability	IBM Bluemix	AWS Elastic Beanstalk	Google App Engine	Oracle Cloud	Microsoft Azure	Heroku
Hybrid Enterprise Content Management	5	5	5	5	5	5
Enrich Application	5	5	5	5	5	4
In-context Collaboration	4	5	3	5	4	5
Average:	4.7	5.0	4.3	5.0	4.7	4.7

Business Offering Analysis						
Cost Efficiency (ranked 2-5 based on cost per metric, 5: highest - excluding charges for services)	IBM Bluemix	AWS Elastic Beanstalk	Google App Engine	Oracle Cloud	Microsoft Azure	Heroku
Website Hosting (High Visitors)	5	2	3	-	4	-
Website Hosting (Low Visitors)	3	2	5	-	4	-
Business Application Hosting (High # Users)	2	4	5	-	3	-
Business Application Hosting (Low # Users)	2	4	5	-	3	-
Data Storage (1TB, 20G Transfer Out, 100K GET Request)	2	3	4	-	5	-
Data Storage (1TB, 20G Transfer Out, 100M GET Request)	4	3	2	-	5	-
Average:	3.0	3.0	4.0	-	4.0	-
Competitiveness as PaaS to Business Customers (1: Not at all Competitive - 5: Extremely Competitive)	IBM Bluemix	Amazon Web Services	Google App Engine	Oracle Cloud	Microsoft Azure	Heroku (owned by Salesforce)
Key Unique Selling Point	Integration with IBM Services	Flexibility, Market Leader	Sandbox Model	Niche for Java & JavaScript	IaaS & PaaS in one	Most SDKs & add-on services
Cross-selling Opportunities	5	4	3 (Few exclusive add-on services for businesses)	4	4	2 (minimum integration with Salesforce products)
Switching Cost for Current Customer Base (1: low, 5: high)	5 (service integration)	2	4 (migration almost impossible)	5 (service integration)	4 (.Net devs, enterprise integration)	2
Loyalty of Customer Base	5 (enterprises)	4 (reliable, trust)	2	5 (enterprises)	4 (Windows Developers, enterprises)	3 (highly usable but enterprises use Salesforce1)
Plenty of Third Party Vendors	3	5	5	1	3	5
Platform Features	5	4	3	2	4	5
Scalability	5	5	5	3 (limited to Java-based)	5	3 (Not highly scalable)
Product Recognition	1	5	3	1	3	4
Company Reputation and Experience as Public Cloud Service Provider	1	5	5	1	3	5
Company Reputation and Experience in PaaS market	3	5	3	2	3	5
Company Reputation and Experience as Enterprise Service Provider	5	3	2	5	5	5
Average Comparative Strength:	3.8	4.2	3.5	3.0	3.8	3.9

Security Analysis						
Security Metrics (FedRAMP Standards)	IBM Bluemix	AWS Elastic Beanstalk	Google App Engine	Oracle Cloud	Microsoft Azure	Heroku
Physical and Environmental Protection (PE)						
Physical and Environmental Protection Policy and Procedures	Y	Y	Y	Y	Y	Y
Risk Assessment (RA)						
Risk Assessment	3	4	5	3	5	3
System and Communications Protection (SC)						
Information In Shared Resources	3	5	3	3	5	3
Denial of Service Protection	4	4	5	3	4	3
System and Information Integrity (SI)						
Flaw Remediation	5	-	5		5	-
Configuration Management (CM)						
Configuration Management Policy and Procedures	3	5	4	3	5	3
Access Restrictions For Change	3	5	4	1	5	2
Security Assessment and Authorization (CA)						
Security Assessment and Authorization Policies and Procedures	3	5	5	3	5	5
Awareness and Training (AT)						
Security Awareness and Training Policy and Procedures	-	5	4	2	5	4
Audit and Accountability (AU)						
Audit and Accountability Policy and Procedures	-	5	5	3	5	4
Maintenance (MA)						
System Maintenance Policy and Procedures	2	5	3	3	5	5
Incident Response (IR)						
Incident Response Policy and Procedures	-	5	4	3	5	5
Incident Response Training	-	4	4	2	-	-
Identification and Authentication (IA)						
Identification and Authentication Policy and Procedures	5	5	5	3	5	5
Contingency Planning (CP)						
Contingency Planning Policy and Procedures	1	-	-	2	4	-
Access Control (AC)						
Access Control Policy and Procedures	5	5	4	3	5	5
Account Management	5	5	5	3	5	5
Separation of Duties	-	3	-	3	4	3
System Use Notification	5	5	5	3	5	5
Wireless Access	-	5	-	3		-
Access Control For Mobile Devices	3	5	5	4	5	5
Publicly Accessible Content	5	4	4	3	5	4