#ibmdevconnect

IBM Cloud Performance and Scalability

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STSM, Cloud Developer Services
IBM

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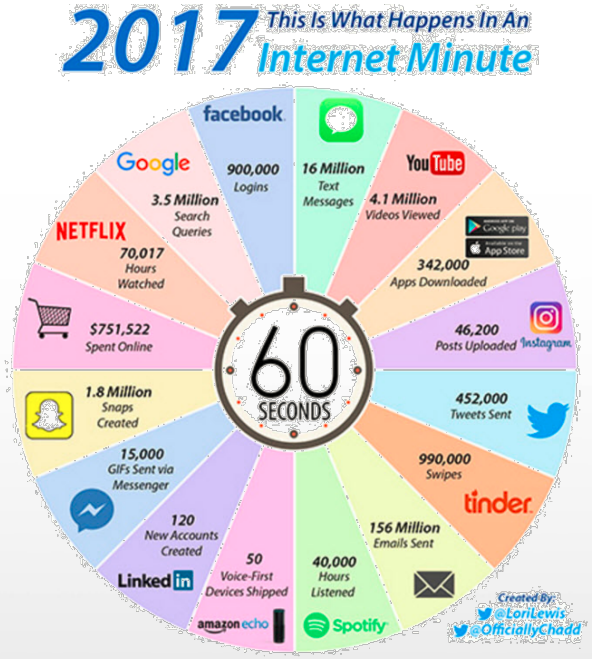
Topics

- Performance characteristics of IBM Bluemix cloud platform
- Microservice architecture and performance
- Hybrid Cloud performance
- Data services selection for better performance
- Tuning tips for Java applications on IBM Bluemix

Cloud Performance

- What performance means for Cloud Platform Consumer ?
  - Unlimited Scalability
  - Guarantee SLAs at peak load
- What performance means for Cloud Platform Provider ?
  - Support more customers per Zone
  - Resolve Integration & Scalability Bottlenecks



- Performance problems manifests as
  - User experience issues – low throughout, high response times, etc.
  - Capacity issues – high CPU, high memory consumption, etc.
- Root cause for performance problems are
  - Application architecture issues
  - Network bandwidth or latency issues
  - Insufficient computational resources
  - Application or platform tuning issues
  - Service integration performance issues
  - Cloud platform issues like noisy neighbors

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Build your apps, your way

Use a combination of the most prominent open-source compute technologies to power your apps. Then, let Bluemix handle the rest.

OpenWhisk

Event-driven apps, deployed in a serverless environment

Instant Runtimes

App-centric runtime environments based on Cloud Foundry

CLOUD FOUNDRY

IBM Containers

Portable and consistent delivery of your app without having to manage an OS

docker

Virtual Machines

Get the most flexibility and control over your environment

openstack POWERED

Bare Metal

For the ultimate performance and scale

openstack POWERED

Ease of getting started

Full stack Control

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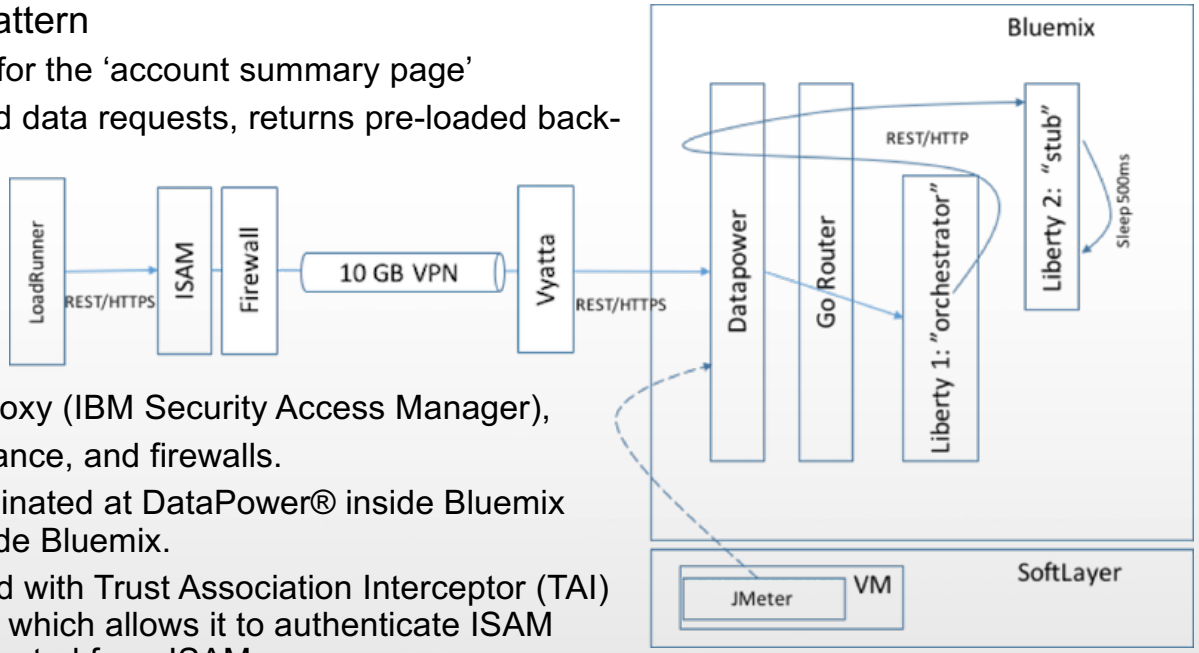
Case study - Online Banking Application

Performance and scalability – Bluemix application on Cloud Foundry

Workload: Customer-facing retail online banking

- Transaction scenario: Open individual account summary page
- Loosely follows the microservices design pattern
  - Orchestrator microservice – provides data for the 'account summary page'
  - Stub microservice – simulates the back-end data requests, returns pre-loaded back-end data after a pre-determined delay



- Workload security
  - On-premises enterprise security reverse proxy (IBM Security Access Manager),
  - VPN connection to Bluemix Dedicated instance, and firewalls.
  - Traffic is encrypted with SSL, which is terminated at DataPower® inside Bluemix and subsequently encrypted via IPSec inside Bluemix.
  - The Orchestrator microservice is configured with Trust Association Interceptor (TAI) login module for Liberty Application Server, which allows it to authenticate ISAM credentials and decode user identity propagated from ISAM.

Performance objective

- Can IBM Bluemix support 500-600 tps peak traffic with sub second response times in production (for the simulated 'Retail Online Banking' application – with UI, Security and Services)?
  - Traffic is encrypted across the board and users are authenticated (using TAI for Liberty)
- Platform stability & consistency, while running the application at peak load for 6-8 Hours

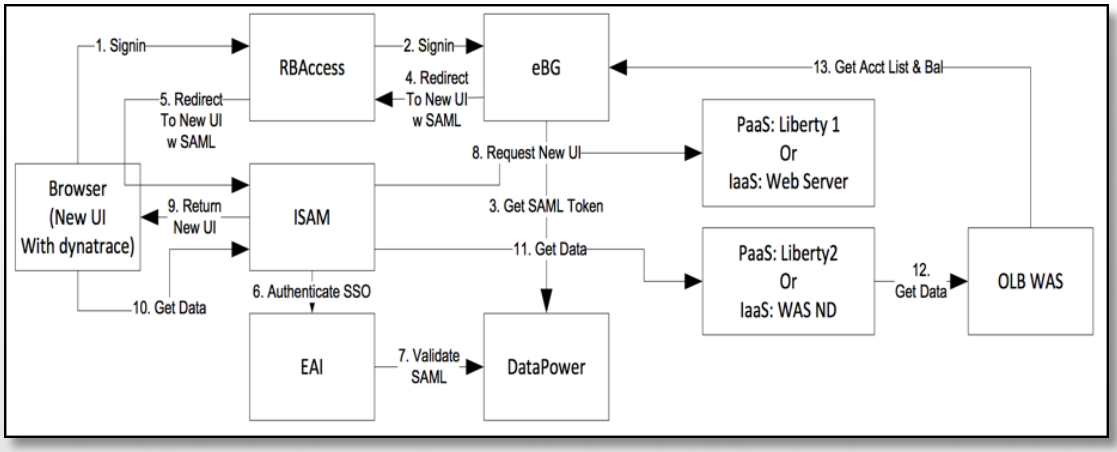


Fig. Online Banking Transaction Flow

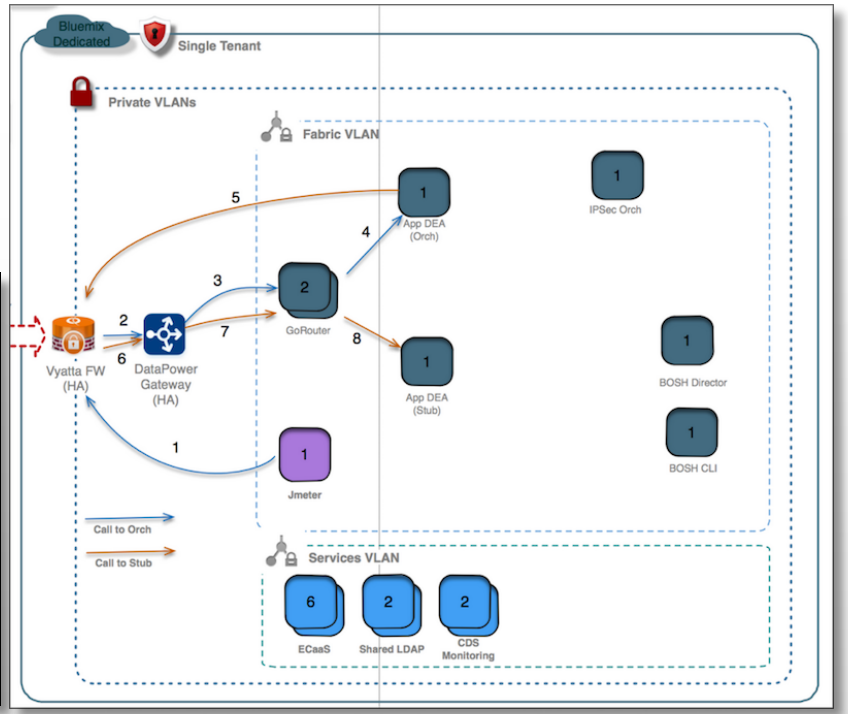
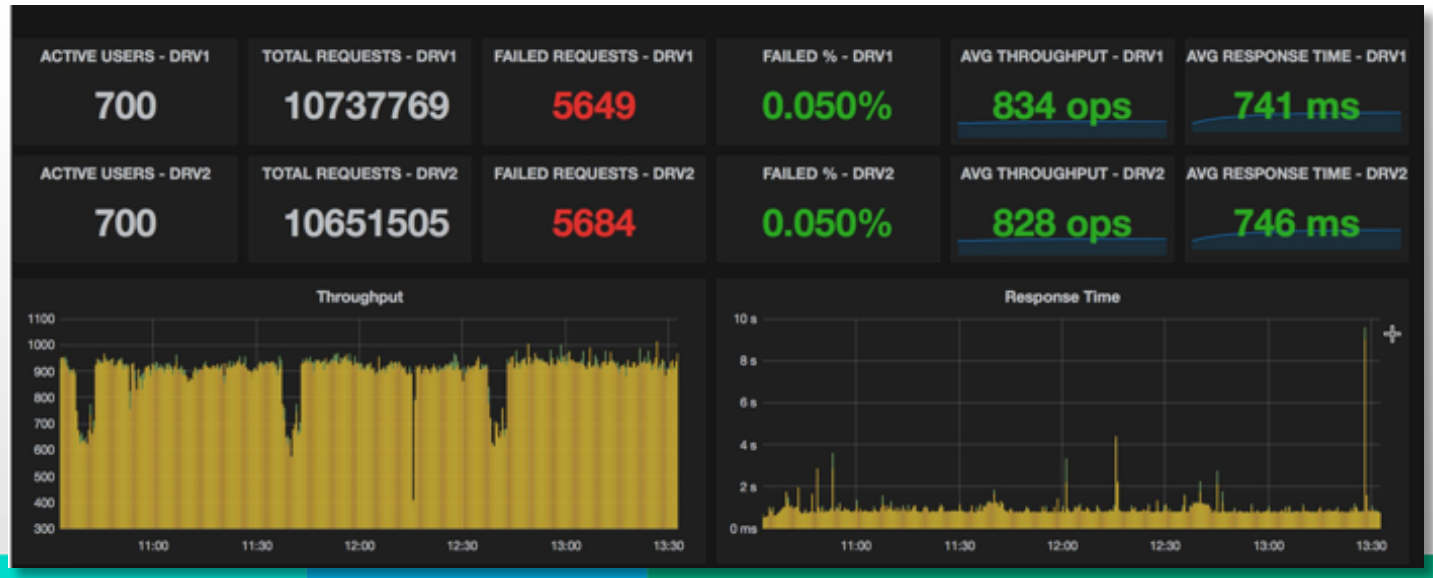


Fig. Network view of the platform: Transactions flow

Performance results

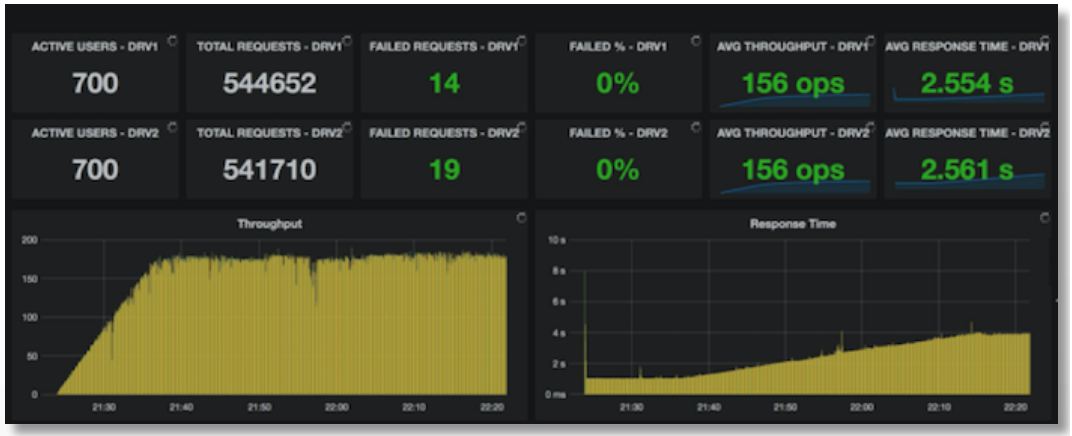
- Can Bluemix support 500-600 OLB tps @sub-second response time with stability over a period of time?
  - **Yes**. more than 21 million HTTP requests were served by 6 application instances
  - Throughput: 831 transactions/sec (1662 REST operations/sec) [> 600 tps]
  - Response time: 741 milliseconds [< 1 sec]
  - Endurance test: sustained peak load for about 6-24 hours continuously

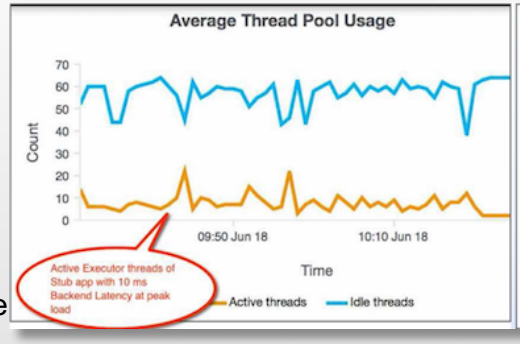


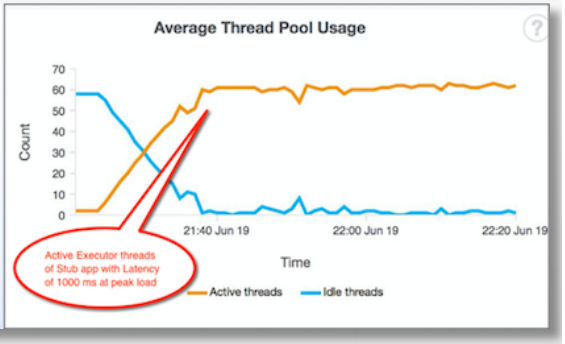
- 6 instances of Orchestrator and Stub services
  - Orchestrator: ~98% avg CPU usage
  - Stub: ~45% avg CPU usage
- capacity available for other apps

Guidelines - Impact of back-end service latency

- Stub services – simulated the backend latency
  - 100-200 milliseconds (eg. mainframe application)
- Observed poor performance (high backend latency)
  - Cause: Liberty thread management algorithm
    - adjusts the thread pool size dynamically based on the workload
    - works well for normal latency scenarios
    - should not be used for high latency scenarios
- Guidance
  - Always measure the back-end service latency
  - Observe the executor thread pool behavior at peak load, for the Java application to identify latency issue
  - For high latency backend
    - bypass the default Liberty threading algorithm
    - explicitly set the executor thread pools in server.xml file of the application







Online banking application case study - summary

Other guidances

- Sticky sessions on auto-scaling
  - Impacts horizontal scalability
  - Disable sticky session (in web.xml) to ensure that the load is uniformly distributed amongst the dynamically provisioned application instances
- Java heap tuning
  - Java heap sizing is ensures optimum performance Java application, and can avoid Out of Memory (OOM) situations,
  - For Java applications, the correct heap size can be found through some iterative testing at peak load or by inspecting the verbose garbage collection data.

Summary

- Bluemix cloud platform can support the required peak performance levels (more than 72 million API calls per day with sub-second response time) with required agility and elasticity.
- Assess back-end service latency and auto-scale session affinity to avoid performance issues.
- IBM Bluemix cloud platform is designed for mission critical enterprise banking applications.

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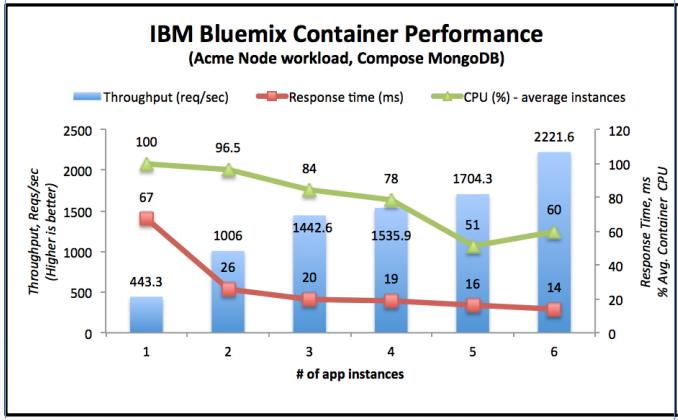
IBM Container Services

Performance & Scalability

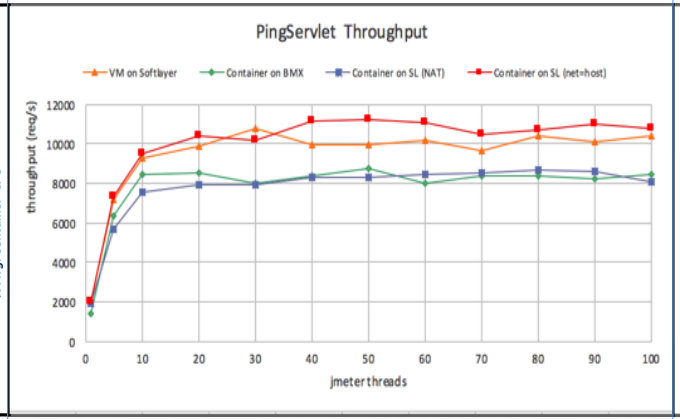
Application Performance on IBM Container Services (gen-1)

Node Application



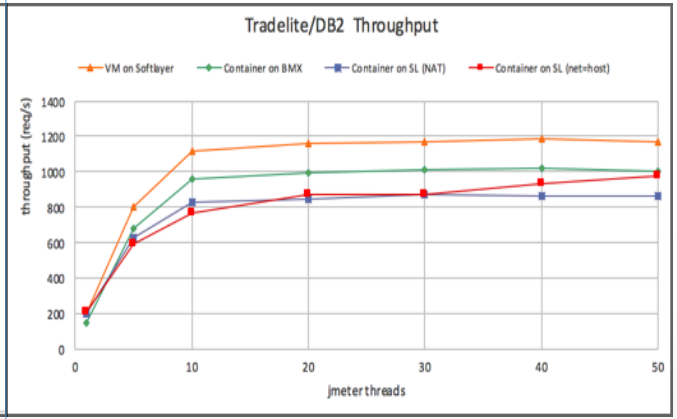
- Illustrates the horizontal scalability with multiple container instances supporting the workload with specified throughput

Network Intensive Java Applications



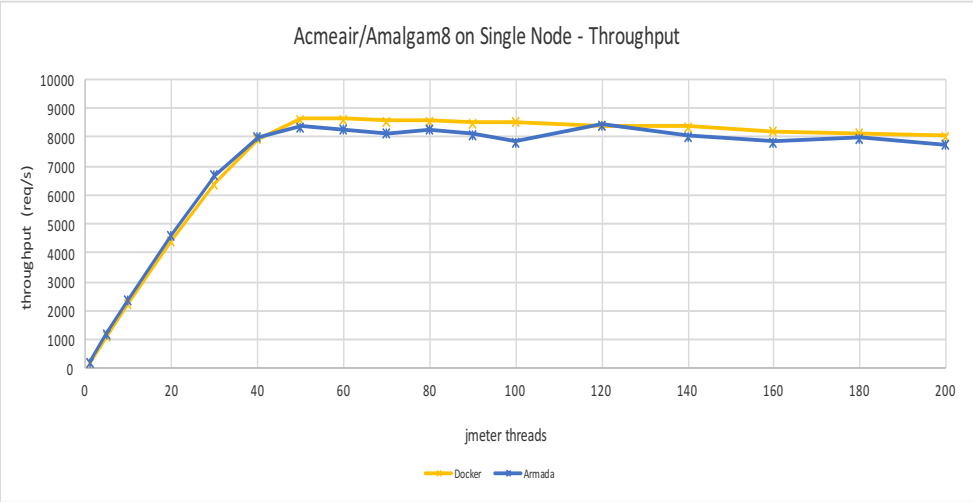
- Network intensive applications running on Bluemix Containers need about 20% more compute power compared to containers running on SoftLayer
- Setting a network option of `net=host` gives better performance for network intensive workloads while running on Docker Containers on SL, mainly eliminating NAT overhead

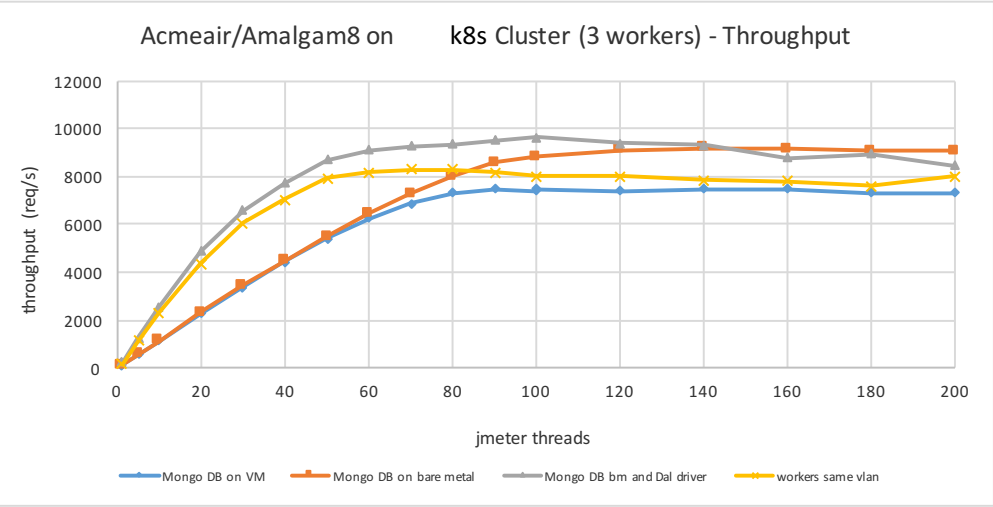
Data Intensive Java Applications



- For data intensive applications, need about 20% higher compute power running on IBM Containers compared to running on SoftLayer VMs
- The network option of `net=host` does not impact much on data intensive applications running on Containers on SL
- For data intensive applications, Containers on Bluemix perform better

Application Performance on IBM Container Services (gen-2)



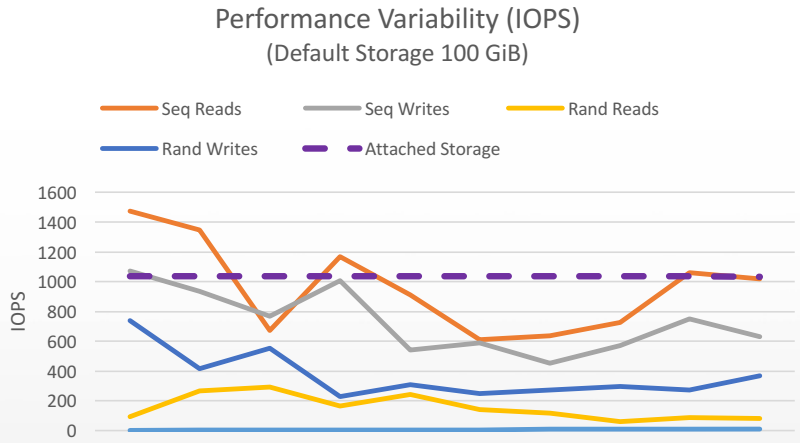


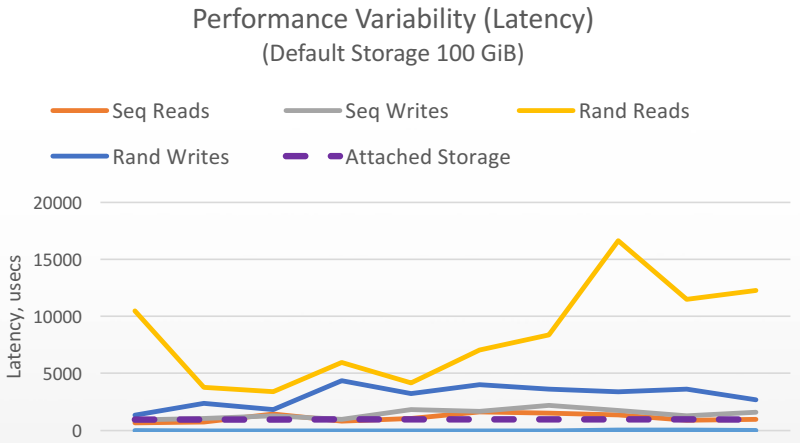
- No additional overhead for applications on Kubernetes (k8s) cluster, when compared to running directly on a Docker container on SL VM with E2E Workloads
- Both IBM Container Services (k8s) and direct Docker Container on SL VM showcase similar scalability characteristics

- Network Latency that will affect scalability of apps in the cluster
  - from Client to app on the Kubernetes cluster
  - from app in the Kubernetes cluster to Data Service

Application Performance on IBM Container Services (gen-2)

Impact of attached storage on performance





- Compared to default storage, attached storage helps towards stable performance of applications on IBM Container Services (on Kubernetes)

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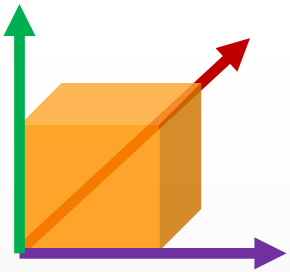
Microservice Performance

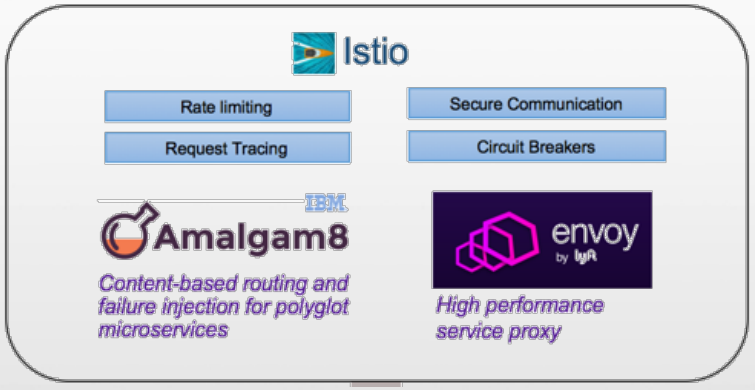
Microservices design considerations

- 12-factor application design principles
  - https://12factor.net/

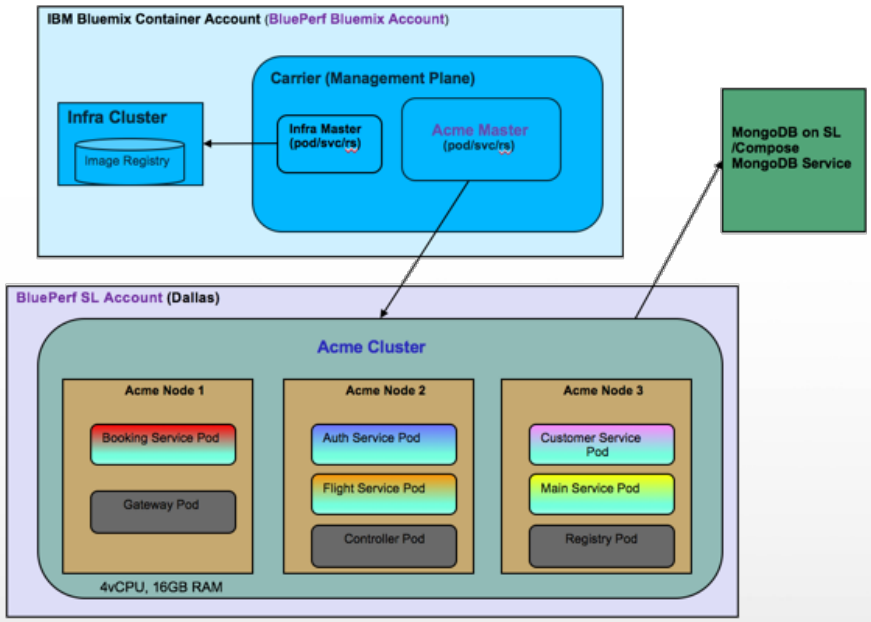


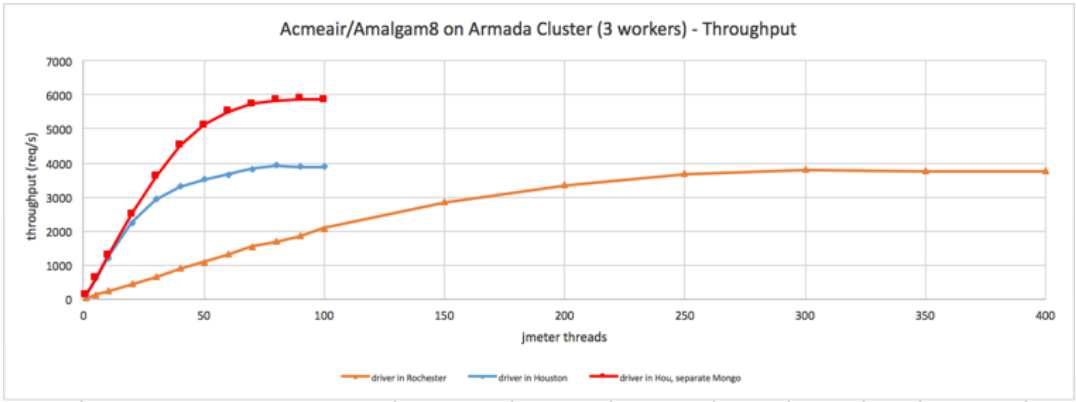
- Z-axis scalability
  - Scale Cube

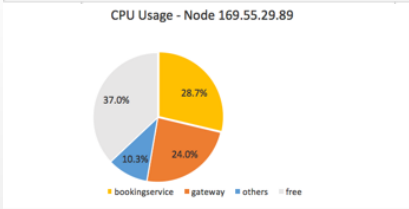
- Selection of critical Fabric Services
  - Service Proxy
  - Service Discovery
  - Resiliency

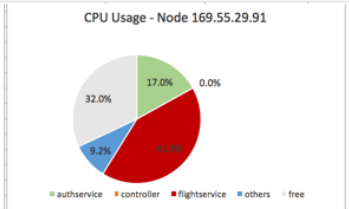


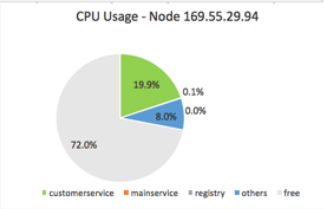
IBM Container Services performance (Acmeair Microservices App)

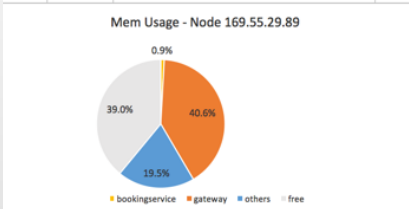


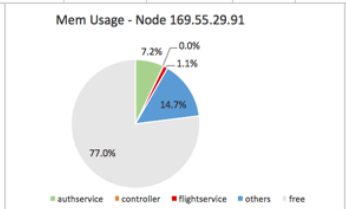


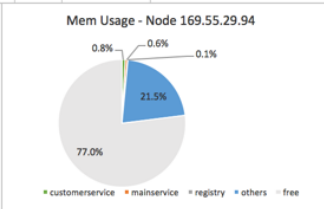






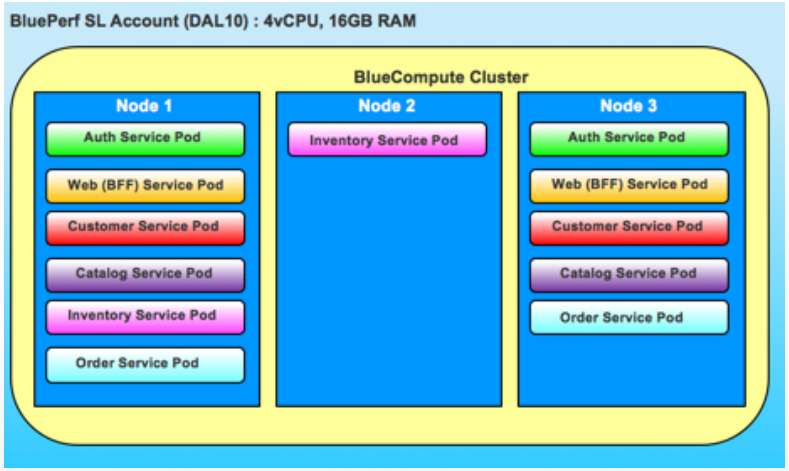




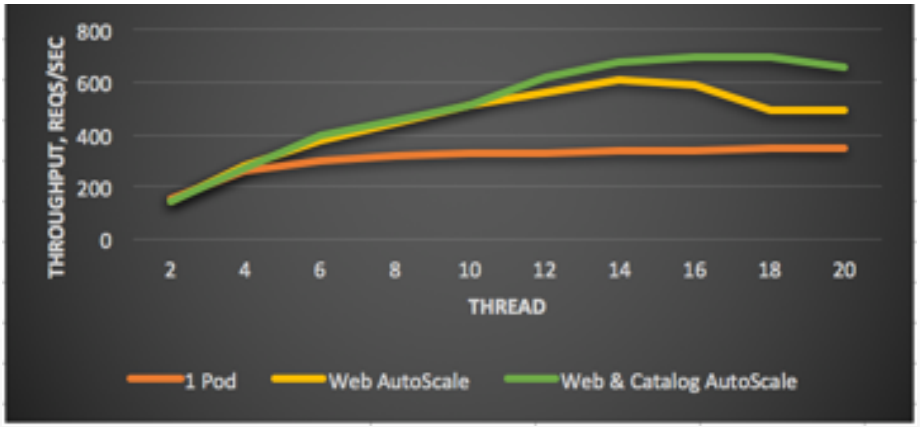


- Acme air microservices running on Kubernetes clusters on IBM Bluemix Container Service
- Correct distribution of services across Pods is crucial for microservices scalability

IBM Container Services performance (Acmeair Microservices App)



Microservice scalability (BlueCompute auto-scale)



- BlueCompute microservices application scaling on Kubernetes Cluster using auto-scale policy
- Z-axis scaling is possible through giving enough resources to Web and Catalog services more instances
- Guidance
  - Leverage z-axis scaling in a scale-cube
  - Allocate the right compute power to the microservices to maximize performance
  - Observation: JAX-RS Client invocations have higher overhead compared to simple HTTP service invocations

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Hybrid Cloud Performance

Performance & scalability

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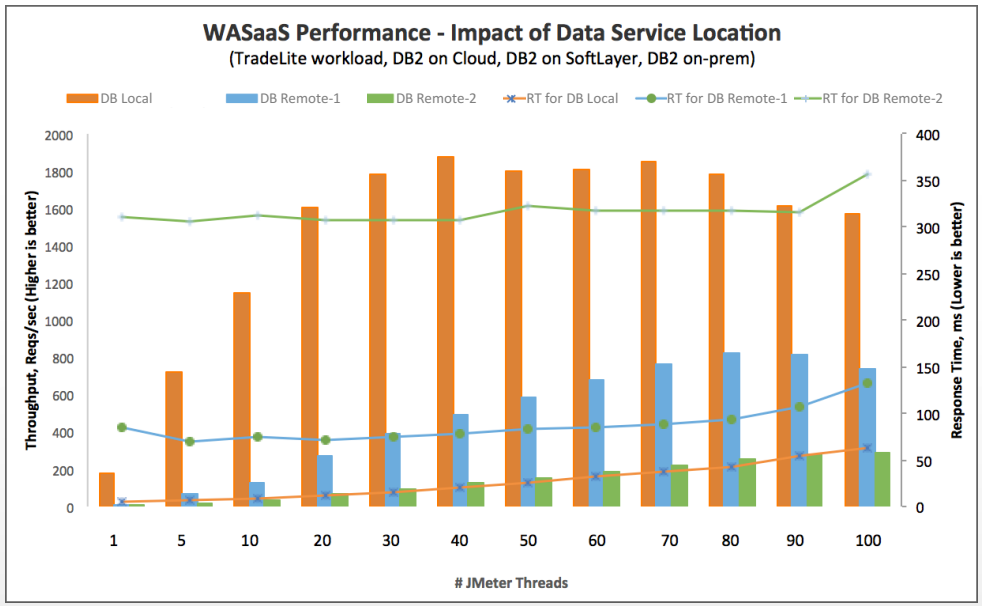
Considerations for Hybrid Cloud scalability

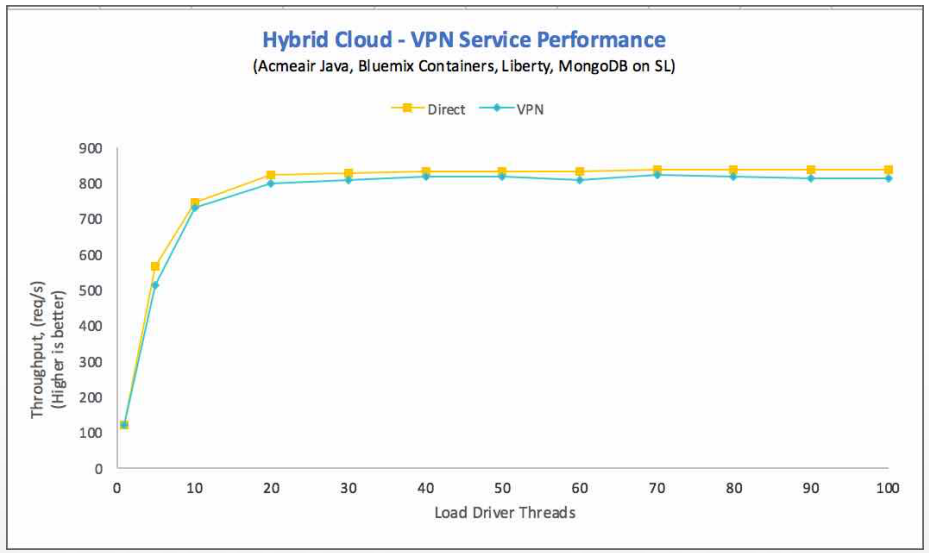
- Network Latency between Cloud applications and On Premise resources
- Selection of right Bluemix service for accessing On Premise resources
- VPN Overhead Considerations
- Secure Gateway Tuning Considerations
- VPN Service Tuning Considerations

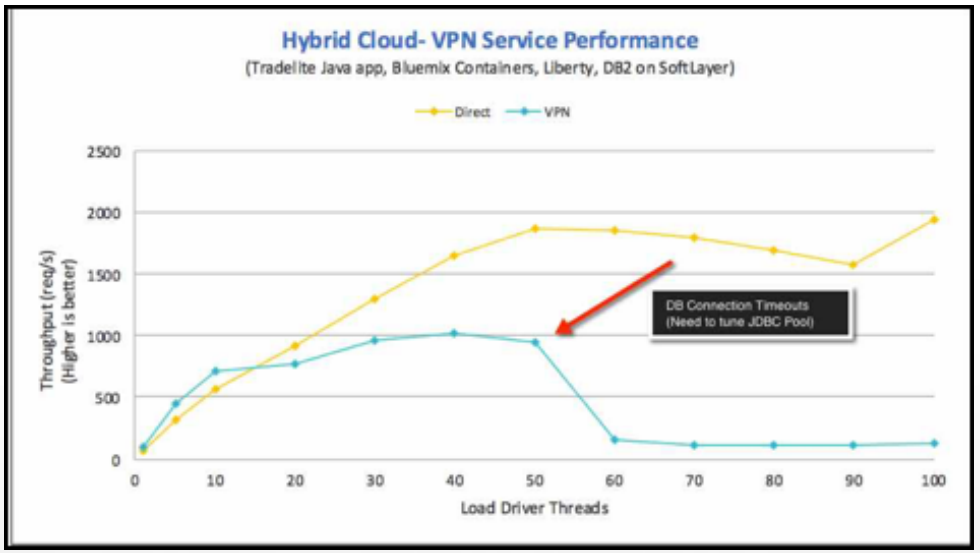
Impact of network latency

- Performance of apps deployed in WASaaS connecting to remote db depends heavily on network latency
- Performance of app accessing data from remote location (remote-1) is much slower than accessing the data from another remote location (remote-2) that is farther (network-distance)
- For the remote DB access scenario, the best way to reduce the network latency is to use a direct dedicated line between the data centers which can reduce the overhead to meet the SLAs



VPN Service performance



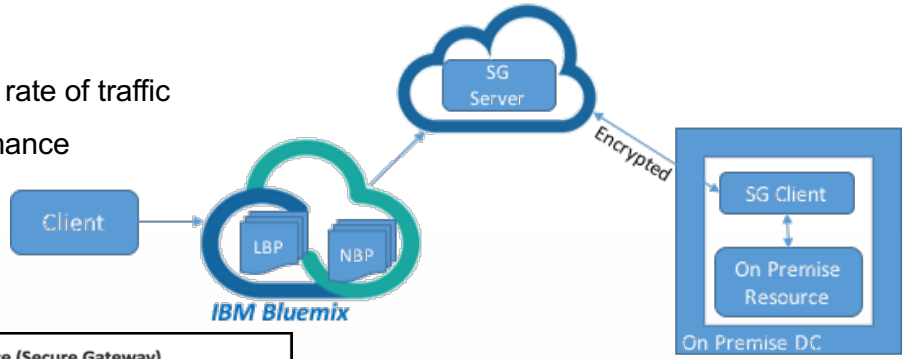


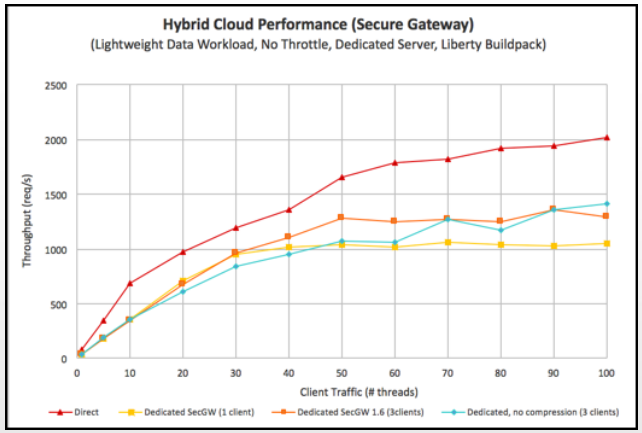
- Performance and scalability of Bluemix VPN Service used for Hybrid Cloud on Bluemix Containers with data centric workloads
- Cloud scale Java application accessing remote DB Service through VPN Service performs similar to a Direct access scenario as the VPN service overhead is very small

- While working on Data centric workloads, for a better scalability with VPN service, tune the JDBC pools correctly

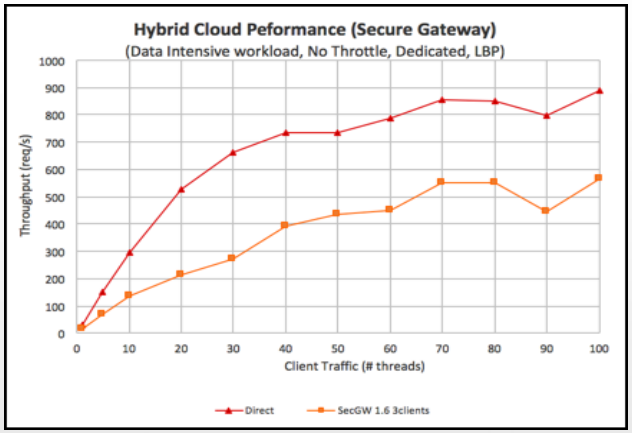
Secure Gateway performance

- Secure Gateway is used to access on premise services
- Public Secure Gateway Service has a throttle mechanism that controls the rate of traffic
- Parallelizing the traffic between SW Server and Client will Improve Performance
- The data traffic determines the overhead of Secure Gateway





- Secure Gateway Service Performance on Bluemix (Lighter Data Traffic)



- Secure Gateway Service Performance on Bluemix (Data Intensive)

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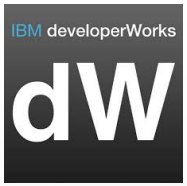
Code & instructions available here
https://github.com/IBMDevConnect17



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IBM Cloud Performance and Scalability

Thank You

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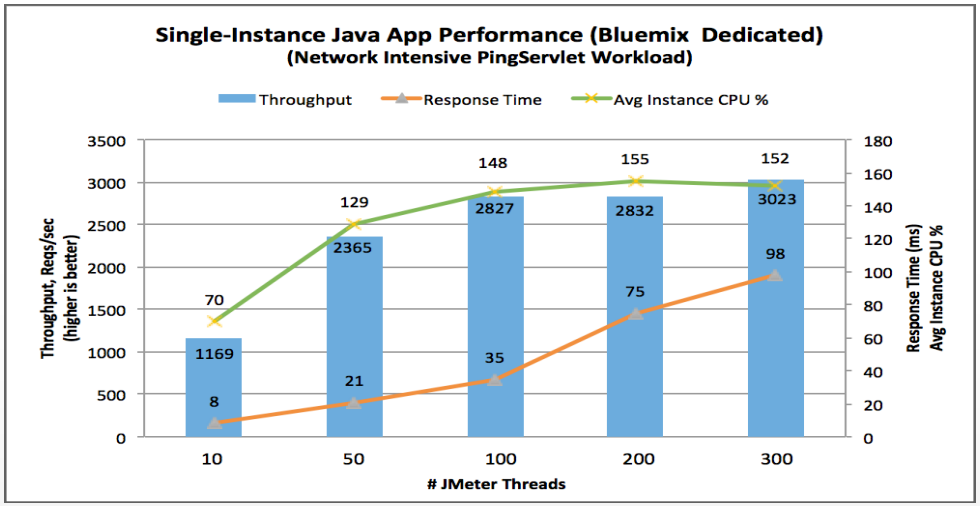
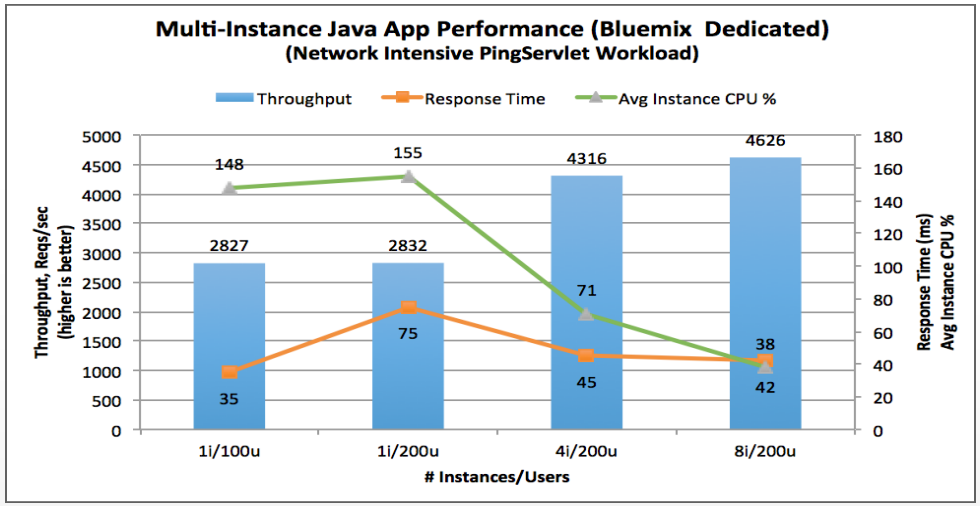
Scalability of Network Intensive Application on IBM Bluemix (Single vs. Multiple instance)

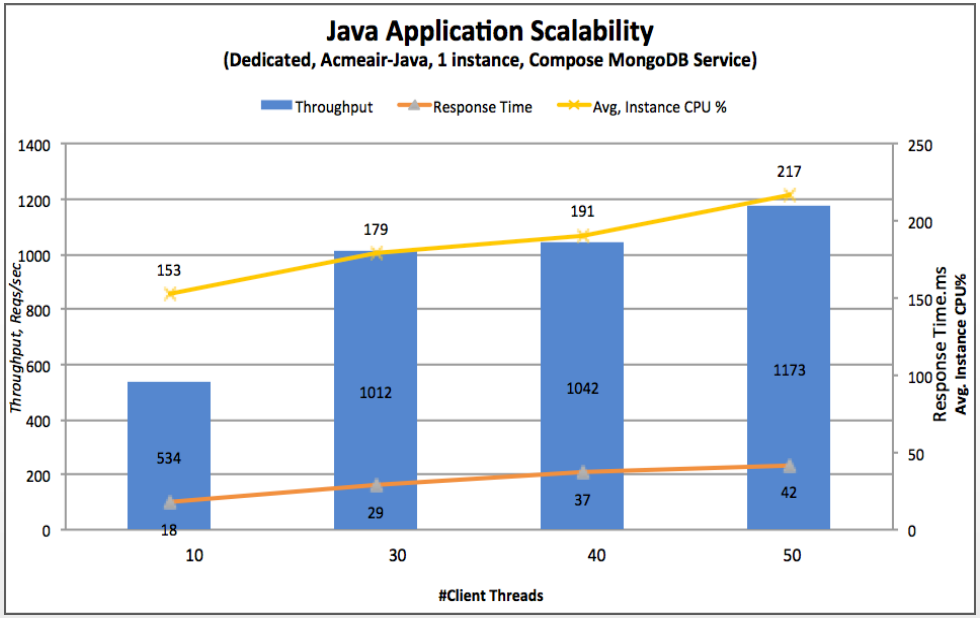


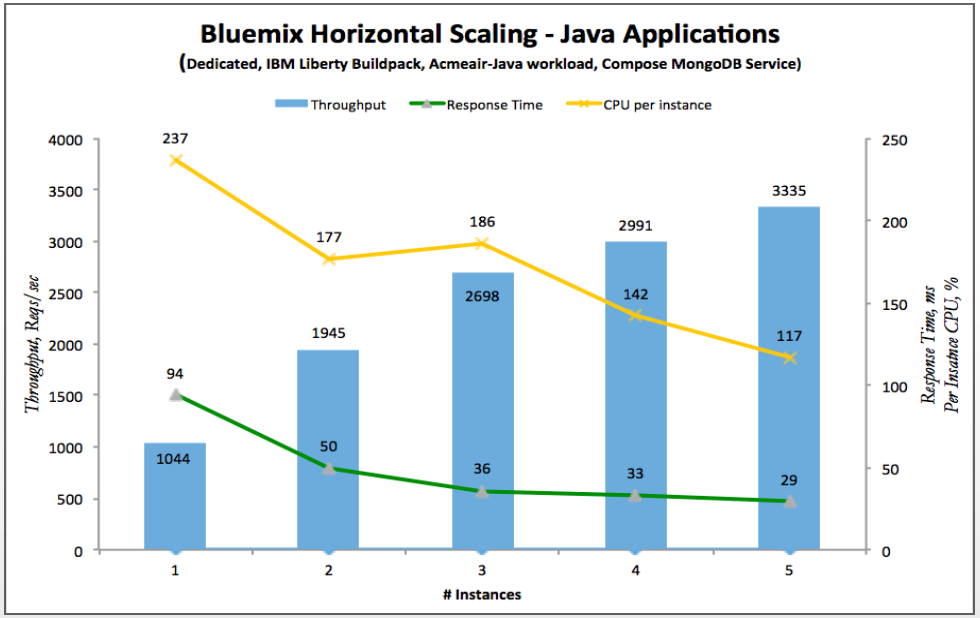


- Very lightweight network intensive java workloads running in Bluemix Dedicated with Liberty Buildpack
- Each instance can support 2827 reqs/sec at response time of 35 ms
- 'Knee of the curve' reached by 100 JMeter threads, beyond which - its recommended to scale horizontally
- After saturating at 100 concurrent JMeter threads, doubling the load only increased the response time without much change in throughput
- By spreading the load to 4-8 instances, the response time dropped with increased throughput

Scalability of Java Application on IBM Bluemix (Single vs. Multiple instance)

- Bluemix Dedicated is a high performing Cloud Platform for Java workloads using Liberty Buildpack

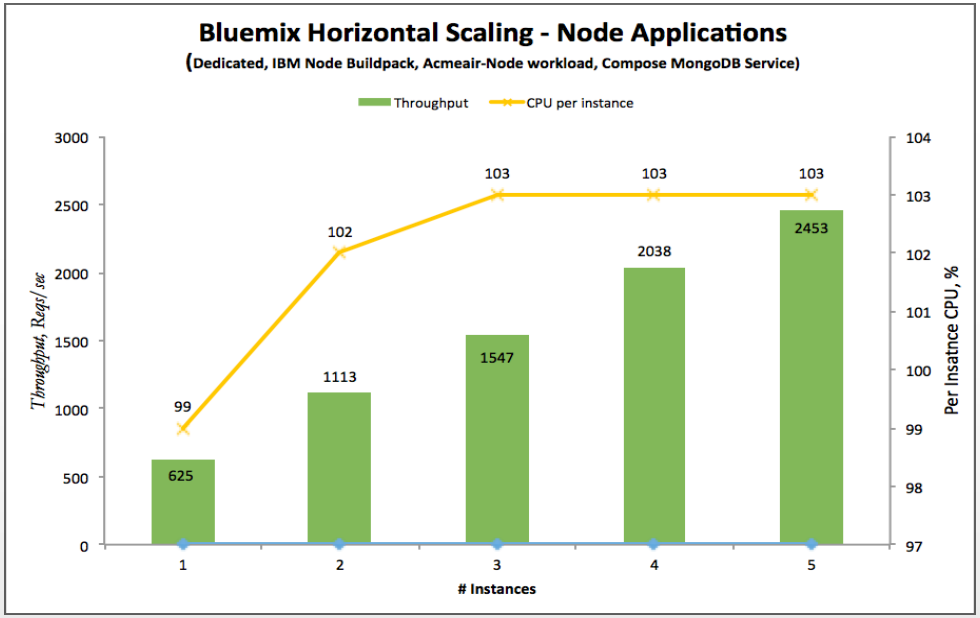


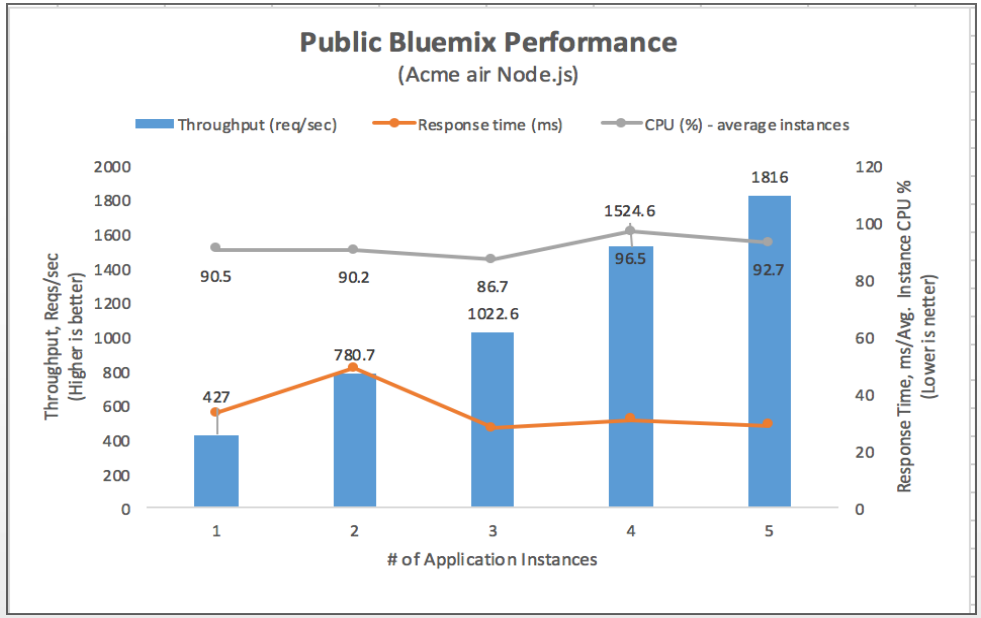


- A single instance of an application can support significant number of transactions at reasonable response time
- Peak load can be supported with multiple application instances scaling horizontally

Scalability of Node Application on IBM Bluemix (Single vs. Multiple instance)

- Bluemix Dedicated & Public is a high scalable Cloud Platform for Node workloads using IBM Node Runtime





- Peak load can be supported with multiple application instances scaling horizontally with low response times

- Compared to Dedicated Bluemix performance, Public Bluemix performance is slightly lower and will be impacted by other tenants using the platform

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Cloud Data services

Selection for better performance

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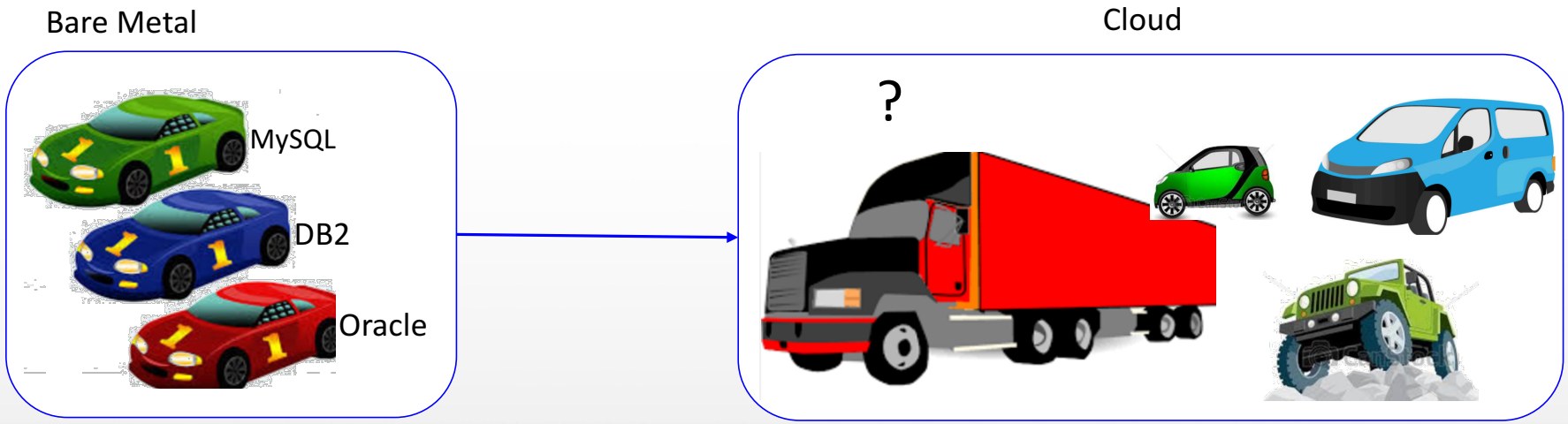
Database Selection shift from Bare Metal to Cloud



Now the database runs on Cloud.
Which DB to choose?

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Database characteristics consideration

- Atomic vs. Non-Atomic
  - A series of database operations either all occur, or nothing occurs
    In case of partial insert/update/delete, its operation will be rolled back
- Storage (Memory vs. Disk)
  - Data can be saved in memory or disk. Some databases first save data in memory, then periodically write to disk. Depending on the design, some databases are durable and others are write acknowledge, or non-durable at all
- Scale/Sharding
  - Scalability is achieved by splitting the data sets into multiple shard servers. Depending on the database, grouping of each data set in each sharding is different
- High Availability & Data Consistency
  - Primary & secondary replica sets vs. Quorum
    - High Data consistency is achieved by Primary & Secondary replica sets, however, Quorum also has mechanism for the data consistency at some level
    - Quorum is highly available in multiple regions. Primary & secondary replica sets can achieve high availability using multiple copies of replica sets as long as the router is accessible and a complete replica set is accessible from this router

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Types of Database

There are 14 known different types/models of Database (http://db-engines.com/en/ranking).
Here are some known Database Systems

- Relational DBMS
  - Use Structured Query Language to query data spread around multiple tables using join operation
  - Use BCNF Database Design to save structured data (although to gain performance, it is better to de-normalize it)
  - All fields must be populated with data (if there is no data, store null)
  - Difficult to change database schema (design)
  - Difficult to horizontally scale if the data is normalized to multiple tables & needs to be joined to provide results.
- Document Stores
  - Able to store unstructured data
  - Use Domain Driven Design (DDD) to save unstructured data
  - There are no set fields. Stores only data (if there is no data, it won't store)
  - No database schema, any JSON format can be saved
  - Data is saved per JSON document. All related data are easily queried
- Key-value Stores
  - Value (dictionary/hash) is retrieved using a key
  - It uses far less memory to store data
  - Treat data as a single opaque collection which provides flexibility
- Wide Column Stores
  - It is a type of key-value model
  - Query-first schema design. All possible queries need to be identified first, then group together the data that will be read together for better performance
  - It uses tables, rows and columns with compound primary key. One or more primary key values act as a "column name", and using one or more primary keys to search & manipulate values
  - Database schema is fixed at the beginning. Changing the database schema might cause massive code change.
- Graph DBMS
  - Use Nodes, edges and properties to represent data
  - It allows simple rapid data retrieval of complex hierarchical structures

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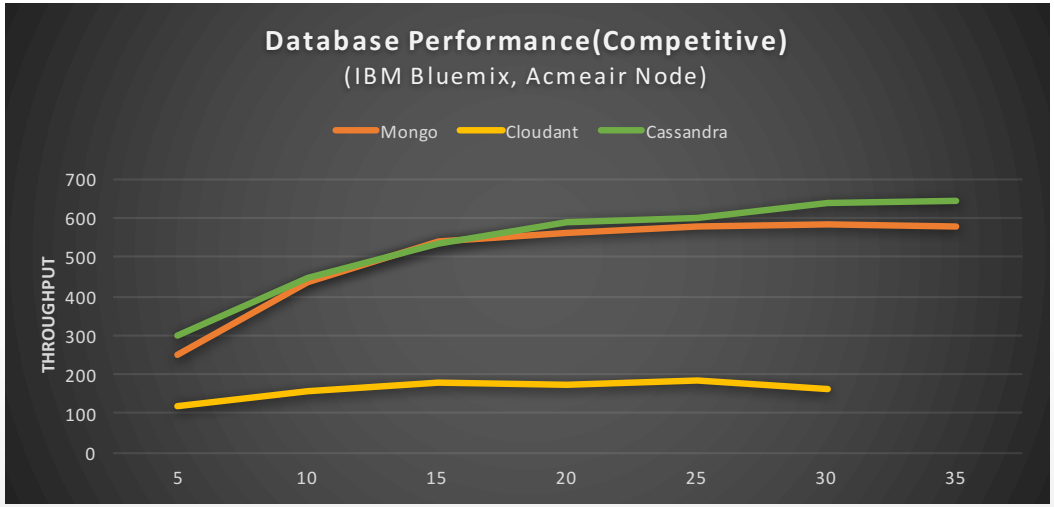
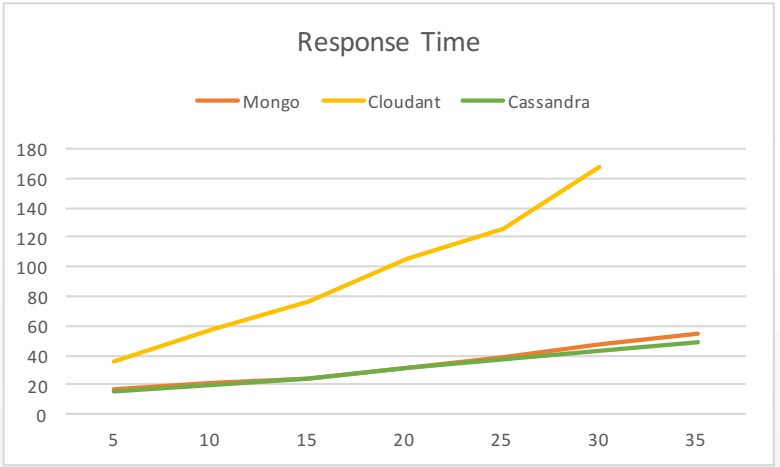
Data Service selection criteria

Database Name	Type	Atomc	Storage	High Availability	Consistency
Cloudant/Couch DB	Document	Yes	Disk	Quorum	User to choose right data
Mongo DB	Document	Yes	In memory - write to disk every 60 sec	Primary	Yes
Cassandra/syllus	Wide Column	No	Disk	Quorum	Auto pick the latest data
Neo4j	Graph	Yes	Disk		Yes
IBM Graph/TinkerPop	Graph	?	?	?	
Riak	Key-Value		Disk	Quorum	
Redis	Key-Value	Yes	In memory	Primary	Yes
Hbase	Wide Column			Primary	Yes
Postgre SQL	RDBMS	Yes	Disk	Primary	Yes

Database Name	Operations good at	Strength	Weakness
Cloudant/Couch DB	Insert, Query	Semi-structured data, not compex queries, HTTP operation	Update & delete needs 2 operations, no deletion or alteration
Mongo DB	Insert, Query, Update, Delete	Semi-structured data, not compex queries	Write to disk every 60 seconds. Enabling journaling will impact perf to 33 req/sec
Cassandra/syllus	insert	Access few colums of many rows at once, fast insert, slower query	If write is corrupted, it may cause multi version of rows with different columns
Neo4j	Insert, Query	Relationships between values (e.g. social media)	
IBM Graph/TinkerPop		Relationships between values (e.g. social media)	
Riak		query by key, key-value pair, HTTP operation	
Redis		query by key, key-value pair	Write every 2 seconds to disk
Hbase		Access few colums of many rows at once	
Postgre SQL	Insert, Query, Update, Delete	Fixed Schema, complex queries	Not flexible, not for Unstructured data

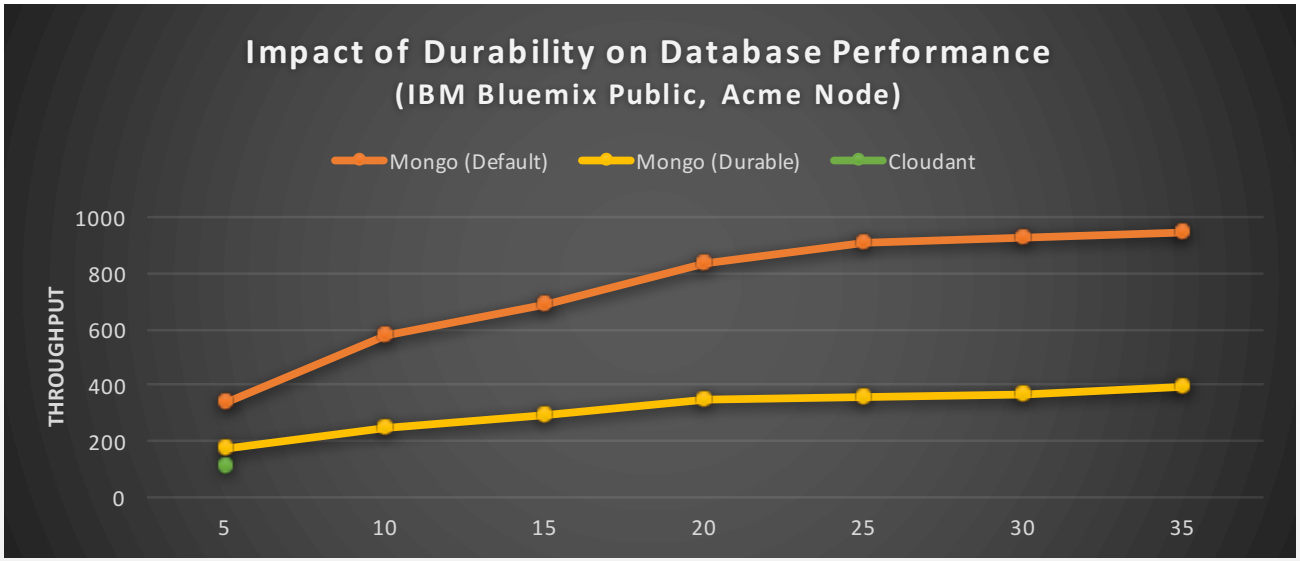
Data Service performance





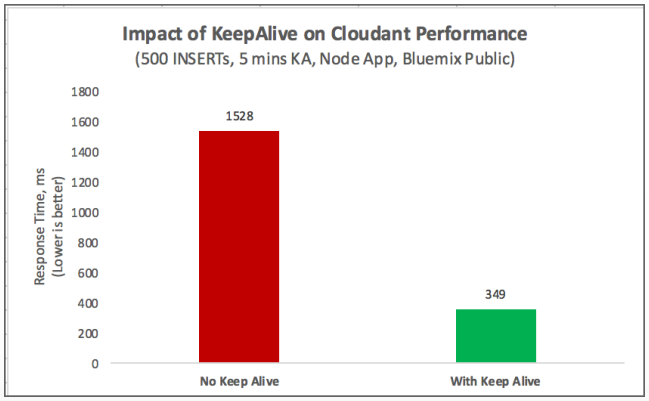
- Select the correct Data Service to get greater application performance and scalability
- Review the Data service best practices and apply them for production for better performance

Impact of durability on Data Service performance



- Database durability QoS impacts the performance
- Understand the default durability of the data service and adjust as per the requirements of the application

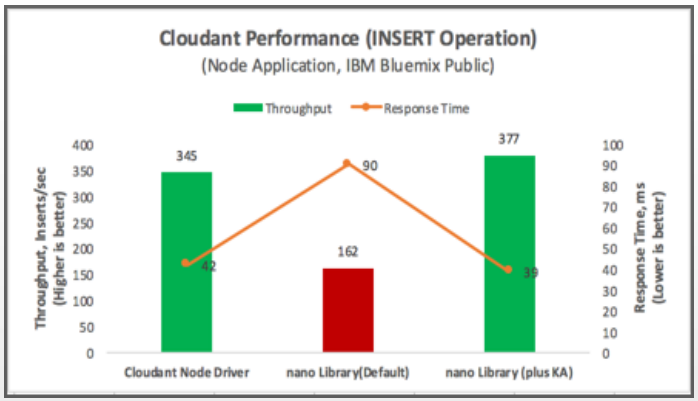
Impact of Keep Alive on Cloudant Performance

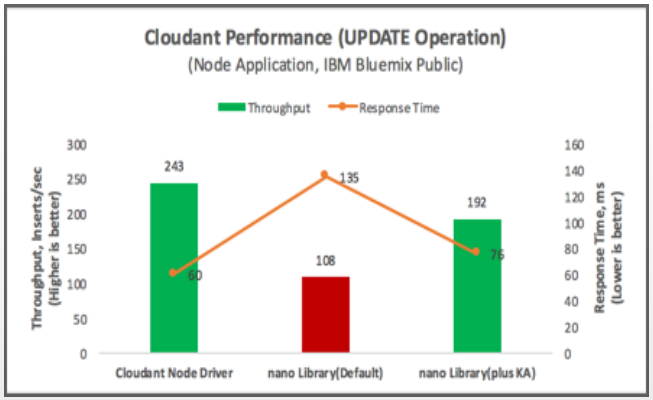


- Cloudant server has Keep-Alive timeout value of 2.5 mins
- Since Cloudant is based on HTTP model, Keep-Alive setting is crucial for performance

Cloudant client libraries

- Most of the applications use Nano / PouchDB libraries,
  Update these libraries with Keep-Alive support to get the best performance
- Both UPDATE and INSERT operations incur significant performance degradation without Keep Alive





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Java application on Bluemix

Performance tuning tips

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Performance tuning tips for Java Applications on Bluemix

- For better performance of most Java applications, reduce the backend service latency
- For larger backend service latency Java applications,
  - avoid using default Liberty Threading model and use manual Executor thread configuration instead
  - increase the Executor thread pool size to a much higher value based on the expected peak load
- While setting the manual thread pool size, set the core threads to a value that is required for peak load not depending much on expansion process to Max Threads
- Java applications need higher Heap Size compared to Node and Swift applications
- Tune and configure the heap/JVM appropriately for the peak load, in order to avoid Out-Of-Memory situations,
- Increase the concurrency for better availability and performance of Online Banking type applications
- Disable sticky sessions while using auto-scale service to avoid uneven load balancing