Making MQ Application Development Easier

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Presentation includes source code

Agenda

- Overview
- Learn-MQ
- Runtime access
- New Languages
  - Go
  - JavaScript

Developer engagement

- MQ can be hard to get going with for new developers
- How do we make it easier for new application teams to pick up MQ and integrate with their development practices?
- Not always been a product focus – spent more time on administration enablement

Developer resources

Knowledge Centre

Google

MQSeries.net

Internal Doc

stackoverflow

*>50% coders have fewer than 5 years' professional experience**

*https://insights.stackoverflow.com/survey/2018

developerWorks

Developer engagement – Mission Statement

To enable a user instructed to use MQ for the first time, to go from zero understanding to ***running*** a sample application in a sandbox environment with a fundamental understanding of MQ concepts in 2 hours

To enable an application developer, instructed to use MQ for the first time, to go from zero understanding to ***writing*** their first MQ application in the language and environment of their choice within an afternoon

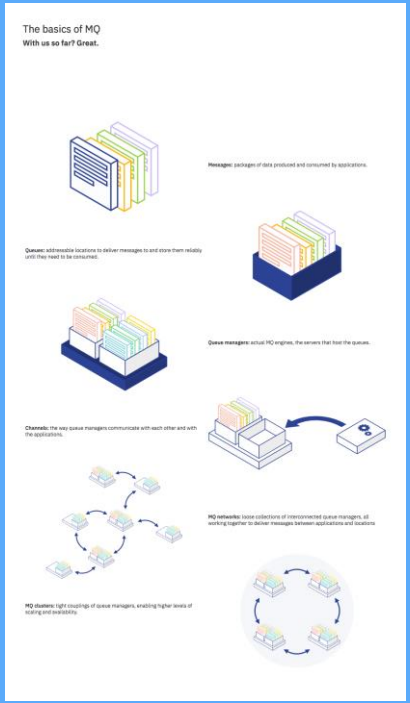
LearnMQ

Finding it hard to get developers started with MQ?

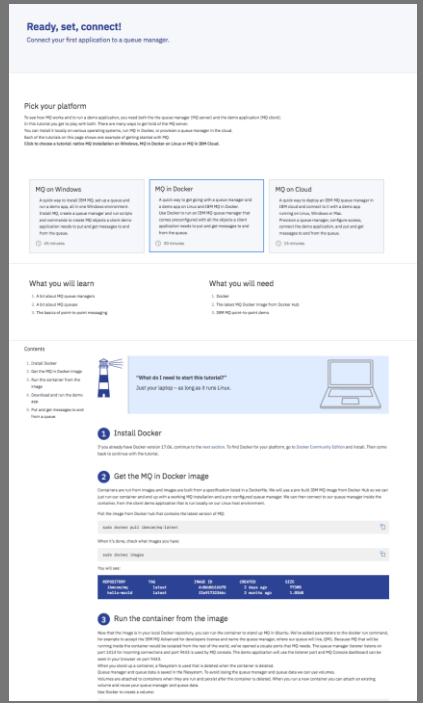
Point them to:

developer.ibm.com/messaging/learn-mq

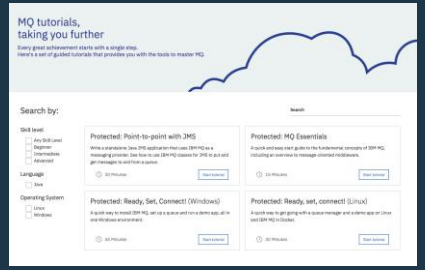
Totally new to MQ? Learn the basics

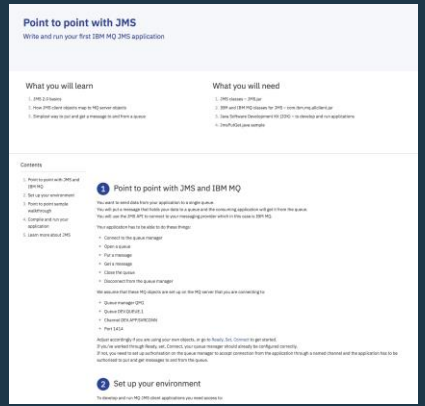


Step-by-step guide to getting up and running with MQ



Tutorials on building your applications





Candidate tutorials, samples & assets

Connect Securely	Write a production JMS app	Write a production c# (.NET) app	Write a publish Subscribe app	Write a C app	Deliver a microclimate app	Deliver a Spring App
Transactions	Languages	JEE	Recipes & scripts	REST	Deployment	Patterns
Protocols	Monitoring	Advanced samples & templates	Trouble-shooting	Testing	Delivery Support	…

Not just about the language or education

- Developers also need easy access to interfaces – no matter their experience
- Do not want to have to install full products

- Many IDEs and build tools integrate with public repositories
- MQ Java interfaces now available from Central Repository (Maven)
  - No need to explicitly install or download
  - Just reference MQ jars in application configuration

Gradle: build.gradle

```
dependencies {
compile("com.ibm.mq:com.ibm.mq.allclient:9.1.0.0")
}
```

Maven: pom.xml

```
<dependency>
    <groupId>com.ibm.mq</groupId>
    <artifactId>com.ibm.mq.allclient</artifactId>
    <version>9.1.0.0</version>
</dependency>
```

Easier ways to get started – Java

- Many Java developers use Spring
  - Can reduce amount of code needed
  - MQ JMS used with Spring for many years
- Spring Boot & Auto-configure give further code reduction
  - You can get a program running quickly
  - With default capabilities
- MQ now has Spring Boot starter
  - Versions for both Boot 1 and Boot 2
  - Source on github; jar on Maven Central

build.gradle

```
dependencies {
compile("com.ibm.mq:mq-jms-spring-boot-starter:+")
}
```

https://developer.ibm.com/messaging/2018/04/03/mq-jms-spring-boot/

Easier ways to get started – runtime availability

- Docker container with full MQ server function
  - Creates sample objects for developers
  - Queues, topics, userids etc
- See github.com/ibm-messaging/container with several build options

- Redistributable Client packages now easier to access
  - To make it easy for developers to package standalone applications
  - Perhaps in a container
  - No login required to download
- See https://public.dhe.ibm.com/ibmdl/export/pub/software/websphere/messaging/mqdev/redist/

Language Interfaces to MQ

Multiple APIs and Protocols

IBM MQ supports multiple APIs and multiple client protocols. Both proprietary and open.

APIs: **MQI**, **JMS**, **MQ Light**, **REST** …

Protocols: **MQ**, **AMQP**, **MQTT**, **HTTP**

These support a wide range of application styles, from the simplest of messaging needs through to the most sophisticated

MQ is simply the broker of messages produced from any API, protocol or language

MQ
MQ's highly reliable and performant messaging protocol

MQTT
MQ Advanced supports the MQTT protocol
Open source Eclipse Paho clients

AMQP
Support for AMQP 1.0 enables support for open source clients such as Qpid Proton

HTTP
A very simple but secure messaging API over REST

MQI
Exposes the full set of MQ capabilities
Uses the MQ protocol

JMS
Supports the full JMS API for use in many JSE or JEE environments

MQ Light
A simple pub/sub messaging API
Uses the AMQP 1.0 protocol

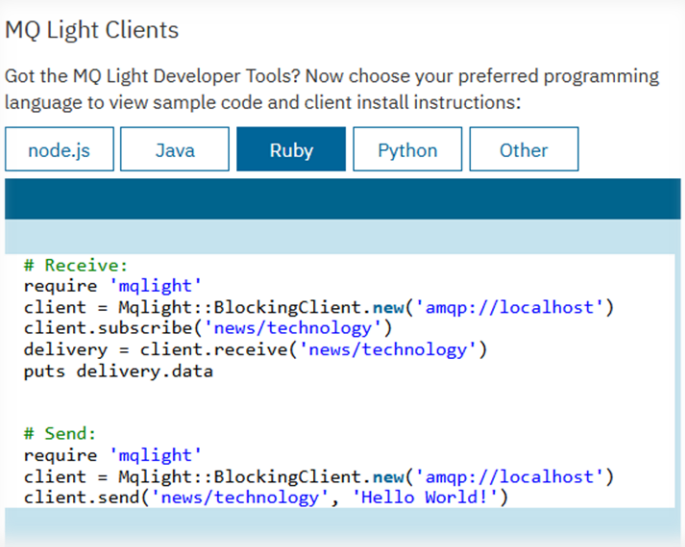
MQTT
Support for the MQTT API for IoT devices

Messages from one application can be received by any other application, independent of API or protocol.

MQ Light APIs

- MQ Light interfaces in a variety of languages
  - Client source in GitHub
- And integrated with natural public repository
  - JavaScript: NPM
  - Java: Maven
  - Ruby: gem install mqlight
  - Python: pip install mqlight
- .Net information at

  https://developer.ibm.com/messaging/2017/11/13/mq-light-messaging-microsoft-net-part-1/



The classic MQI

- The full-function MQI has primarily been used from C, Java and COBOL

- Other languages for the MQI have been in the product but used less
  - PL/1
  - RPG
  - C++
  - etc

- On Distributed platforms many of these are built on top of the C library
  - The COBOL bindings, for example, are a small mapping layer
- The "pure" bindings (.Net, Java) have to reimplement all the protocols

Example C code

Buffers for character strings

```
char QMName[MQ_Q_MGR_NAME_LENGTH] = {0};

strncpy(QMName, "QM1", (size_t)MQ_Q_MGR_NAME_LENGTH);


MQCONNX(QMName,                  /* queue manager                  */
        &cno,                    /* connection options             */
        &Hcon,                   /* connection handle              */
        &CompCode,               /* completion code                */
        &CReason),               /* reason code                    */
```

Fixed length – ensure no overflow

Multiple values returned via pointers

Function with no direct return code

None of these hard to work with, but not always natural

Designed this way for performance, commonality and extensibility

New interfaces - convergence of requirements

- Demonstrate monitoring capabilities of MQ with newer technologies

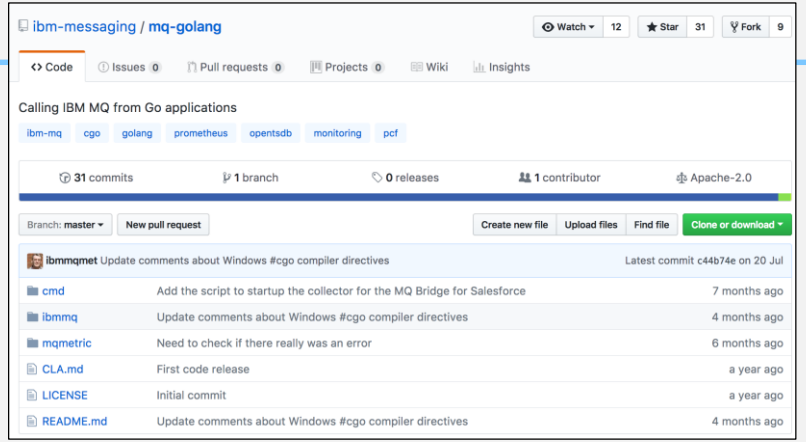
- Developers writing applications in a broader variety of languages
  - What do they know? What do they prefer to use?
  - Often do not have a choice as other aspects – toolkits, standards etc drive decisions
- Need to integrate with package managers for ease of access

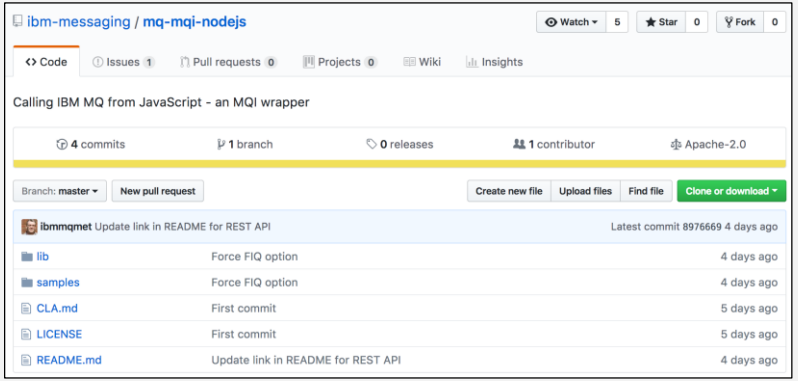
Full MQI capability

- MQ Light APIs not rich enough for all the things I needed to do
- Simplified APIs are always prone to needing to expose just one more thing …
- Building on C MQI runtime libraries means not reimplementing protocol flows
  - Makes the language bindings thin
- Still allowing higher level, pattern-based components to be built
  - For example, a single API call to do request-and-wait-for-reply, or wait-then-send-reply which incorporates best practices for handling CorrelId and MsgId, or poison messages

New bindings released to GitHub

- Interfaces for Go and Node.js designed around full MQI function
- Provided as as-is open source
- Pull requests can be accepted





3rd party language interfaces

- Varying maintenance, capabilities, license

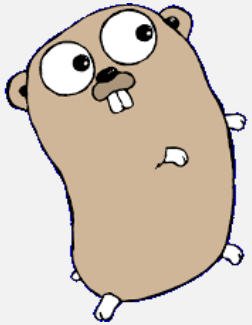
  Perl: search.cpan.org/dist/MQSeries/

  PHP: pecl.php.net/package/mqseries

  Python: pythonhosted.org/pymqi/

  Ruby: github.com/reidmorrison/rubywmq

- Also built on top of C MQI library



GO

https://github.com/ibm-messaging/mq-golang

Monitoring with Prometheus

- Given a requirement to work with a monitoring solution
- Prometheus was one of the most popular metric stores (time-series DB)
- Standard toolkit for getting data to Prometheus was in Go
  - Collector program needed to be written in Go while also processing MQ messages
  - But we had no Go API for MQ …
  - There is now a Java Prometheus client, but too late for this requirement

What is Go

- Language from Google
- Often called golang (easier for searching!)
  - Removes some of the dangerous features of C like pointers
  - Fast compilation times
  - Distinctive approaches to particular problems:
    - Built-in concurrency primitives (channels, go-routines)
    - Implicit object class inheritance
    - Toolchain produces statically linked native binaries without external dependencies.
  - Make the common things for common patterns easy
- Standard external repository managers – particularly github
  - You can easily exploit these packages in your own programs
- Good set of standard packages

Where is it used

- Many projects in infrastructure and systems
- For example,
  - Docker
  - Hyperledger
  - Prometheus
- And a large set of toolkits to help build other projects

The usual starter

```
package main

import "fmt"

func main() {
    fmt.Println("Hello, World")
}
```

"import" refers to standard libraries
or
to automatically-installed/downloaded packages

Indentation not critical but formatter applies it consistently

Getting to MQ from Go

- Go includes a mechanism – "cgo" – for calling C libraries from Go programs

- Can refer to C headers and structures in Go programs
  - Making use of them, though, is a bit more tricky
  - Similar to writing a JNI layer for Java/C interaction
  - Explicitly state when code goes outside Go's safety boundaries
- The cgo system does not include standard C pre-processing.
  - No #ifdef for conditional compilation, though there are whole-file optional inclusions
  - It is possible to do some limited #ifdef at the top of the file for the C code
  - Makes it harder to share code between platforms and versions
  - Could be done via intermediate build step

The design

- Go deals with "packages"
  - Analagous to libraries in C, package in Java

- Created an ibmmq package that maps the MQI into and out of Go
  - Layered on top of the MQ C client interface
  - To build it requires the C client and SDK
- Functions (MQI verbs) and structures
- Constants made available in Go-native format

- Making the MQI look more natural to a Go programmer
  - Structures use Go strings

Function calls

- A Go function can return multiple results, one of which usually indicates errors

```
MQOPEN(hConn, &hObj, &mqOD, options, &cc, &rc);
```

becomes

```
hObj, err := qmgr.Open(mqOD, options)
```

- where qmgr encapsulates the hConn
- and err encapsulates both cc and rc values
- "if err != nil …" for error checking (and note no parens on the *if*)

- Based on MQI verb names rather than Java's *qMgr.accessQueue()* style

Start of an MQ program

```
import (
        "fmt"
        "os"
        "strings"

        "github.com/ibm-messaging/mq-golang/ibmmq"
)
```

Where do we get it from

Opening a queue

```
mqod := ibmmq.NewMQOD()
openOptions = ibmmq.MQOO_OUTPUT |
              ibmmq.MQOO_FAIL_IF_QUIESCING |
              ibmmq.MQOO_INPUT_AS_Q_DEF
mqod.ObjectType = ibmmq.MQOT_Q
mqod.ObjectName = "SYSTEM.DEFAULT.LOCAL.QUEUE"
qObject, err = qMgr.Open(mqod, openOptions)
if err != nil {
  fmt.Println(err)
}
```

Initialise default values

Refer to constants

Simple string

Call MQ and get hObj

Opening a queue

```
mqod := ibmmq.NewMQOD()
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Putting a message

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qObject, err = qMgr.Open(mqod, openOptions)
if err != nil {
  fmt.Println(err)
}
```

```
mqmd := ibmmq.NewMQMD()
pmo  := ibmmq.NewMQPMO()
mqmd.Format = "MQSTR"
msg  := "Hello from Go"

buffer := []byte(msg)
err = qObject.Put(mqmd, pmo, buffer)
if err != nil {
  fmt.Println(err)
}
```

Go has '=' and ':='

Some more strings

No need to say how long message is

Putting a message

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if err != nil {
  fmt.Println(err)
}
```

Some more strings

No need to say how long message is

Getting a message

Where will message data go

Look at MQRC value

```
var datalen int
getmqmd := ibmmq.NewMQMD()
gmo := ibmmq.NewMQGMO()
gmo.Options = ibmmq.MQGMO_NO_SYNCPOINT |
 ibmmq.MQGMO_FAIL_IF_QUIESCING | ibmmq.MQGMO_WAIT
gmo.WaitInterval = 3000

buffer := make([]byte, 32768)
datalen, err = qObject.Get(getmqmd, gmo, buffer)
if err != nil {
  fmt.Println(err)
  mqret := err.(*ibmmq.MQReturn)
  if mqret.MQRC == ibmmq.MQRC_NO_MSG_AVAILABLE {
    err = nil
  }
} else {
  fmt.Printf("Got message of length %d: ", datalen)
  fmt.Println(strings.TrimSpace(string(buffer[:datalen])))
}
```

```
mqmd := ibmmq.New
pmo  := ibmmq.New
mqmd.Format = "MQ
msg  := "Hello fr

buffer := []byte(
err = qObject.Put
if err != nil {
  fmt.Println(err
}
```

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if err != nil {
  fmt.Println(err)
  mqret := err.(*ibmmq.MQReturn)
  if mqret.MQRC == ibmmq.MQRC_NO_MSG_AVAILABLE {
    err = nil
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```
mqmd := ibmmq.New
pmo  := ibmmq.New
mqmd.Format = "MQ
msg  := "Hello fr

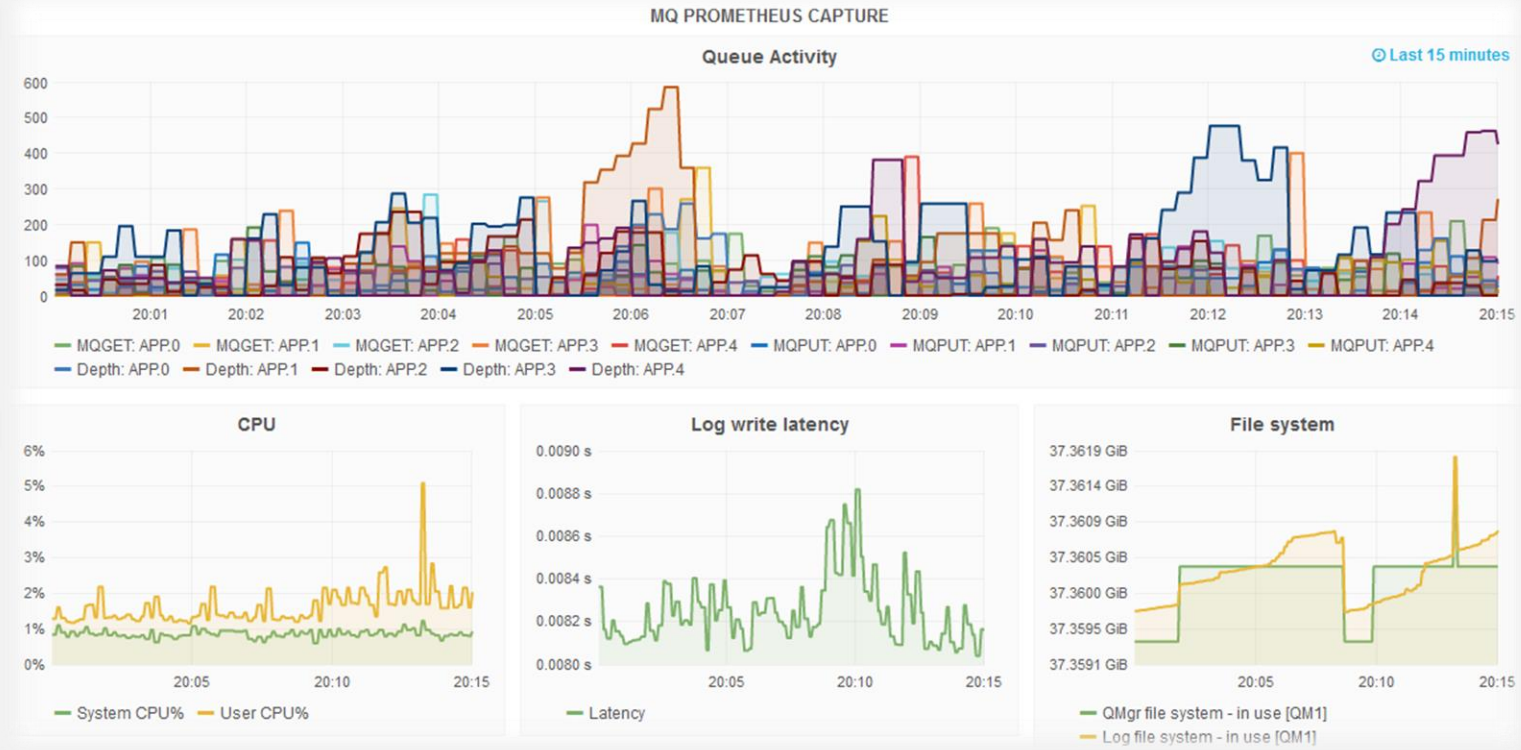
buffer := []byte(
err = qObject.Put
if err != nil {
  fmt.Println(err
}
```

The mqmetric package

- Also in the repository is the mqmetric package to handle some PCF operations
- Comparable to the Java PCF classes

- Created to allow execution of basic queries and parse responses
  - Not all PCF element structures, just the ones needed for the monitoring agents

Grafana dashboard



What is missing

- Not all the MQI has been implemented

- Missing verbs: MQSET, MQxxxMP, MQCB/MQCTL, MQSTAT, MQBEGIN
- Not all the structure fields have been implemented (eg Distribution Lists)

- No message header generation or parsing except for some PCF
  - Structures like the RFH2, DLH headers

Current status

- Original repository now split to make it easier to get just the pieces you need
- mq-golang has the core MQI and PCF packages
  - Some sample code to demonstrate use of most functions
  - Assumes you already know the MQI principles from another language
- mq-metric-samples has Prometheus, Cloudwatch etc monitor programs
  - Along with a "vendor" tree
    - How dependencies can be managed within the Go ecosystem
- Currently being managed and enhanced by the MQ Cloud team

Future thoughts

- Further simplify build and distribution processes

- Add more focussed samples to demonstrate specific features
  - Equivalents of amqsput etc
  - Instead of one or two all-embracing demonstrations

- Reduce number of unimplemented verbs and fields
- (Internal) See what can be automatically generated to reduce effort of hand-crafted layers

https://github.com/ibm-messaging/mq-mqi-nodejs

What is Node.js

- Run-time environment to execute standalone JavaScript programs
  - Rather than embedded in HTML pages, executed by browser
- Main technical distinction: highly asynchronous, for event-driven programming
  - Lots of tasks handled via callback functions
  - All user code runs on a single main thread (no parallel execution)
- No real relation to Java apart from the name and some syntax
- Standard external repository manager – npm
  - You can (all too) easily reference and use these packages in your own programs

Where is it used

- Many users of "server" applications written in Node.js
  - https://www.netguru.co/blog/top-companies-used-nodejs-production

- Organisations listed include Netflix, ebay, Wal-mart, Uber, NASA

The usual starter

```
console.log("Hello, World")
```

Rather simple!

The usual starter and an example of callback

```
console.log("Hello, World")
```

Rather simple!

```
const fs = require('fs');

fs.copyFile('source.txt', 'destination.txt', function (err) {
  if (err) throw err;
  console.log('source.txt was copied to destination.txt');
});
```

Defines a function that is invoked after the copy has completed

The design

- One package, ibmmq, that exports the MQI
  - Structures, functions and constants
- Async model with exceptions as optional alternative
  - If no callback provided, then most functions indicate errors via exception
  - Some functions always require callback
- Most MQI calls are really synchronous
  - They run immediately to completion on the main execution thread
  - MQGET is different

Getting to MQ from Node.js

- Packages on npm enable access to C interfaces
  - "ffi" (Foreign Function Interface) is the equivalent of dlopen/dlsym
  - "ref" converts between JavaScript datatypes and raw byte buffers

- No direct use of C interface elements was used
  - All structure mappings created by hand
  - There are ways to import/convert C headers but those still need lots of manual fixup
  - Similar to a Java/JNI layer

- Did consider a C++ "Addon" which might permit more asynchronous MQI calls
  - But would probably not help with MQGET callbacks
  - And rather complex to write

MQGET

- Package provides Get() and GetSync() verbs, with unique GetDone()
  - xxxxSync() is common JS pattern
- GetSync() is a blocking wait
  - Not recommended in Node.js programs as it stops any other work being done
  - OK for when WaitInterval is zero
- Get() is an asynchronous operation
  - Callback returns data or failure
  - Keeps returning more messages until GetDone() is called – similar to MQCB model
  - Implemented as a polling MQGET because real MQCB/MQCTL could not be used
  - Poll intervals can be tuned

- Looking at a native async operation for some application patterns

Opening a queue

```
mq = require('ibmmq');
MQC = mq.MQC;

…

var od = new mq.MQOD();
var qName = "SYSTEM.DEFAULT.LOCAL.QUEUE";
od.ObjectName = qName;
od.ObjectType = MQC.MQOT_Q;
var openOptions = MQC.MQOO_INPUT_AS_Q_DEF;
mq.Open(hConn,od,openOptions,function(err,hObj) {
  if (err) {
    console.log("MQ call failed: " + err.message);
  } else {
    console.log("MQOPEN of %s successful",qName);
    getMessages(hObj);
  }
});
```

Access the package

Access the constants within the package

Work with strings and use the constants

Defines a function that is invoked after the Open has completed

Convenient pre-formatted error message

Synchronous Get

```
function getMessage(hObj) {
  var buf = Buffer.alloc(1024);
  var mqmd = new mq.MQMD();
  var gmo = new mq.MQGMO();
  gmo.Options = MQC.MQGMO_NO_SYNCPOINT | MQC.MQGMO_NO_WAIT |
                MQC.MQGMO_CONVERT | MQC.MQGMO_FAIL_IF_QUIESCING;
  mq.GetSync(hObj,mqmd,gmo,buf,function(err,len) {
    if (err) {
       if (err.mqrc == MQC.MQRC_NO_MSG_AVAILABLE)
         console.log("no more messages");
       else
         console.log("MQ call failed: " + err.message);
    } else {
      if (mqmd.Format=="MQSTR")
        console.log("message <%s>", decoder.write(buf.slice(0,len)))
      else
        console.log("binary message: " + buf.slice(0,len));
    }
  });
}
```

Where message data will end up

Sync is OK for NO_WAIT

Can look at MQRC value

Asynchronous Get

```
function getMessages(hObj) {
  var md = new mq.MQMD();
  var gmo = new mq.MQGMO();

  gmo.Options = MQC.MQG
         MQC.MQGMO_CONV
  gmo.MatchOptions = MQ
  gmo.WaitInterval = wa

  // Tune down poll int
  mq.setPollTime(500);
  mq.Get(hObj,md,gmo,ge
}
```

Refer to callback function

Disable callback when no more messages needed

Callback given details of the received message

```
function getCB(err, hObj, gmo,md,buf) {
   if (err) {
     if (err.mqrc == MQC.MQRC_NO_MSG_AVAILABLE)
       console.log("No more messages available.");
     else
       console.log("MQ call failed: " + err.message);
     mq.GetDone(hObj);
   } else {
     if (md.Format=="MQSTR")
       console.log("message <%s>", decoder.write(buf));
     else
       console.log("binary message: " + buf);
   }
}
```

API documentation via JSDoc

Global

Home

Methods

`Back(queueManager, callback)`

Back - Backout an in-flight transaction.

Parameters:

Name	Type	Description
queueManager	MQQueueManager	reference to the queue manager (hConn)
callback	function	optional. Invoked for errors. No additional parameter on success.

Throws:

- Container for MQRC and MQCC values
  Type
  MQError
- When a parameter is of incorrect type
  Type
  TypeError

Class: MQMD

Home

Classes

MQAttr
MQCBC
MQCBD
MQCD
MQCMHO
MQCNO
MQCSP
MQCTLO
MQDMHO
MQDMPO
MQError
MQGMO
MQIMPO
MQMD
MQObject
MQOD
MQPD
MQPMO
MQQueueManager
MQSCO
MQSD
MQSMPO
MQSRO
MQSTS

Global

Back
Begin
Close
Cmit

MQMD()

This is a class containing the fields needed for the MQMD (MQ Message Descriptor) structure. See the MQ Knowledge Center for more details on the usage of each field. Not all of the underlying fields may be exposed in this object.

Constructor

`new MQMD()`

This constructor sets default values for the object.

Members

`AccountingToken :Buffer`

Type:

- Buffer

`ApplIdentityData :String`

Type:

- String

`ApplOriginData :String`

Type:

Automatic installation during deployment

- Refer to ibmmq in your package and C runtime will be automatically installed

```
$ cat package.json
{
  "name": "amqsput",
  "version": "0.0.1",
  "description": "Demo MQ API",
  "main": "amqsput.js",
  "dependencies": {
    "ibmmq": ">=0.7.0"
  }
}
```

```
$ npm install
... (messages show install of other pieces) ...
> ibmmq@0.7.0 postinstall
/tmp/node_modules/ibmmq
> node postinstall.js

Downloading  IBM MQ Redistributable C Client
runtime libraries - version 9.0.5.0
Unpacking libraries...
Removing 9.0.5.0-IBM-MQC-Redist-LinuxX64.tar.gz
amqsput@0.0.1 /tmp
└─┬ ibmmq@0.7.0
  ├─┬ ffi@2.2.0
  │ ├── bindings@1.2.1
  │ ├─┬ debug@2.6.9
... (more about the dependency tree)
```

Containers

- The samples include a Dockerfile showing how to build a container with just your Node.js program in it
- And how to configure client connectivity to a queue manager

```
$ cd node_modules/ibmmq/samples
$ ./run.docker
Sending build context to Docker daemon  87.04kB
Step 1/13 : FROM debian:jessie-slim
 ---> f1ff1c889d54
Step 2/13 : ENV NODE_USER app
...
Step 13/13 : CMD node amqsput ${DOCKER_Q} ${DOCKER_QMGR}
 ---> Using cache
 ---> 0cd6e7086633
Successfully built 0cd6e7086633
Successfully tagged mq-node-demo:latest
Sample AMQSPUT.JS start
MQ call failed in CONNX: MQCC = MQCC_FAILED [2] MQRC = MQRC_NOT_AUTHORIZED [2035]
```

Current status

- All MQI verbs implemented except for MQCTL/MQCB
- Helper for building and parsing DLH recently made available
  - Along with a sample program to show how to use it
- No helpers for other headers such as RFH2
- No PCF classes in this library

Summary

- This presentation has described efforts to improve the developer experience

- To learn about MQ faster
- To make it easier to use MQ from modern development environments

- Feedback will inform future development in these areas

Any questions?