
AWS
re:Invent

SVS406

Understanding state and application workflows with AWS Step Functions

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AWS

AWS re:Invent

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Agenda

- Amazon States Language improvements
- The lifecycle of a single step
- Handling errors
- Parallelism and concurrency
- Additional resources



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Amazon States Language improvements



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Amazon States Language improvements

- Updates to Choice state
- Global access to the context object
- Dynamic timeouts
- Result selector
- String construction
- JSON <-> string conversion
- Array construction



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Choice state – Comparison operators

- *IsNull* – null
- *IsString* – string
- *IsNumeric* – numeric
- *IsBoolean* – Boolean
- *IsTimestamp* – timestamp

```
{
    "Variable": "$.SimpleKey",
    "IsString": true
}
```



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Choice state – Existence test

```
{
    "Variable": "$.ErrorKey",
    "IsPresent": false
}
```

IsPresent



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Choice state – Wildcarding

StringMatches

```
{
    "Variable": "$.SimpleKey",
    "StringMatches": "Simple*"
}
```



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Choice state – Variable to variable comparison

```
{
    "Variable": "$.ResultOneKey",
    "StringEqualsPath": "$.ResultTwoKey"
}
```

StringEqualsPath



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Global access to the context object

Now access the context object in

- *InputPath*
- *OutputPath*
- *ItemsPath* (in Map state)
- *Variable* (in Choice state)
- *ResultSelector*
- Variable to variable comparison



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Turning this . . .

```
{
    "GetExecutionStartTime": {
        "Type": "Pass",
        "Parameters": {
            "ExecutionStartTime.$": "$$.Execution.StartTime"
        },
        "Next": "CheckTimeStamp"
    },
    "CheckTimeStamp": {
        "Type": "Choice",
        "Choices": [
            {
                "Variable": "$.ExecutionStartTime",
                "TimestampGreaterThan": "2020-01-31T12:00:00Z",
                "Next": "NextState"
            }
        ],
        "Default": "DefaultState"
    }
}
```

. . . into this

```
{
    "CheckTimeStamp": {
        "Type": "Choice",
        "Choices": [
            {
                "Variable": "$$.Execution.StartTime",
                "TimestampGreaterThan": "2020-01-31T12:00:00Z",
                "Next": "NextState"
            }
        ],
        "Default": "DefaultState"
    }
}
```

Dynamic timeouts

```
{
    "Type": "Task",
    "Resource": "arn:aws:states:::glue:startJobRun.sync",
    "Parameters": {
        "JobName": "SomeGlueJob"
    },
    "TimeoutSecondsPath": "$.params.maxTime",
    "HeartbeatSecondsPath": "$.params.heartBeat"
}
```

- *TimeoutSecondsPath*
- *HeartbeatSecondsPath*



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Result selector

```
{
    "Type": "Task",
    "Resource": "arn:aws:states:::elasticmapreduce:createCluster.sync",
    "Parameters": {
        ...
    },
    "ResultSelector": {
        "ClusterId.$": "$.Cluster.Id",
        "ClusterName.$": "$.Cluster.Name"
    },
    "ResultPath": "$.EMROutput"
}
```



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Turning this . . .


```
{
    "Cluster": {
        "Applications": [
            {
                "AdditionalInfo": {},
                "Args": [],
                "Name": "Hive",
                "Version": "2.3.5"
            }
        ],
        "AutoTerminate": false,
        "ClusterArn": "arn:aws:elasticmapreduce:us-
east-2:468083054740:cluster/j-9LHV59AWJQFH",
        "Configurations": [],
        "Ec2InstanceAttributes": {
            "AdditionalMasterSecurityGroups": [],
            "AdditionalSlaveSecurityGroups": [],
            "Ec2AvailabilityZone": "us-east-2a",
            "EmrManagedMasterSecurityGroup": "sg-0057d40a91b8690e4",
            "EmrManagedSlaveSecurityGroup": "sg-0e20a658d8ad678d0",
            "IamInstanceProfile": "StepFunctionsSample-
EMRJobManagementea18b9f3-32bf-47cf-a993-ad275e6eb0f3-EMREc2InstanceProfile-
LWQ9SZJYOKFQ",
            "RequestedEc2AvailabilityZones": [],
            "RequestedEc2SubnetIds": []
        },
        "Id": "j-9LHV59AWJQFH",
        "InstanceCollectionType": "INSTANCE_FLEET",
        "KerberosAttributes": {},
        "LogUri": "s3n://stepfunctions-emrproject-468083054740-us-east-2/logs/",
        "MasterPublicDnsName": "ec2-3-137-198-136.us-
east-2.compute.amazonaws.com",
        "Name": "ExampleCluster",
        "NormalizedInstanceHours": 0,
        "PlacementGroups": [],
```

Turning this . . .


```
{
    "Cluster": {
        "Applications": [
            {
                "AdditionalInfo": {},
                "Args": [],
                "Name": "Hive",
                "Version": "2.3.5"
            }
        ],
        "AutoTerminate": false,
        "ClusterArn": "arn:aws:elasticmapreduce:us-
east-2:468083054740:cluster/j-9LHV59AWJQFH",
        "Configurations": [],
        "Ec2InstanceAttributes": {
            "AdditionalMasterSecurityGroups": [],
            "AdditionalSlaveSecurityGroups": [],
            "Ec2AvailabilityZone": "us-east-2a",
            "EmrManagedMasterSecurityGroup": "sg-0057d40a91b8690e4",
            "EmrManagedSlaveSecurityGroup": "sg-0e20a658d8ad678d0",
            "IamInstanceProfile": "StepFunctionsSample-
EMRJobManagementea18b9f3-32bf-47cf-a993-ad275e6eb0f3-EMREc2InstanceProfile-
LWQ9SZJYOKFQ",
            "RequestedEc2AvailabilityZones": [],
            "RequestedEc2SubnetIds": []
        },
        "Id": "j-9LHV59AWJQFH",
        "InstanceCollectionType": "INSTANCE_FLEET",
        "KerberosAttributes": {},
        "LogUri": "s3n://stepfunctions-emrproject-468083054740-us-east-2/logs/",
        "MasterPublicDnsName": "ec2-3-137-198-136.us-
east-2.compute.amazonaws.com",
        "Name": "ExampleCluster",
        "NormalizedInstanceHours": 0,
        "PlacementGroups": [],
        "ReleaseLabel": "emr-5.26.0",
        "ScaleDownBehavior": "TERMINATE_AT_TASK_COMPLETION",
        "ServiceRole": "StepFunctionsSample-EMRJobManagemen-EMRServiceRole-
7D946TM7JP9J",
        "Status": {
            "State": "WAITING",
            "StateChangeReason": {
                "Message": "Cluster ready to run steps."
            },
            "Timeline": {
                "CreationDateTime": 1607650907119,
                "ReadyDateTime": 1607651149325
            }
        },
        "StepConcurrencyLevel": 1,
        "Tags": [],
        "TerminationProtected": false,
        "VisibleToAllUsers": true
    },
    "SdkHttpMetadata": {
        "AllHttpHeaders": {
            "x-amzn-RequestId": [
                "acffdc3e-6322-48a6-9e0d-b438e063b3a4"
            ],
            "Content-Length": [
                "1282"
            ],
            "Date": [
                "Fri, 11 Dec 2020 01:46:43 GMT"
            ],
            "Content-Type": [
                "application/x-amz-json-1.1"
            ]
        },
        "HttpHeaders": {
            "Content-Length": "1282",
            "Content-Type": "application/x-amz-json-1.1",
            "Date": "Fri, 11 Dec 2020 01:46:43 GMT",
            "x-amzn-RequestId": "acffdc3e-6322-48a6-9e0d-b438e063b3a4"
        },
        "HttpStatusCode": 200
    },
    "SdkResponseMetadata": {
        "RequestId": "acffdc3e-6322-48a6-9e0d-b438e063b3a4"
    },
    "ClusterId": "j-9LHV59AWJQFH"
}
```

. . . into this

```
{
    "ClusterId": "j-9LHV59AWJQFH",
    "ClusterName": "ExampleCluster"
}
```

String construction

```
{
    "Parameters": {
        "Message.$": "States.Format('My full name is {} {}.', $.First, $.Last)"
    }
}
```



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JSON <-> string conversion

- *JsonToString*
- *StringToJson*

```
{
    "Type": "Task",
    "Resource": "arn:aws:states:::dynamodb:putItem",
    "Parameters": {
        "TableName.$": "$.TableName",
        "Item": {
            "id": {"S.$": "$.id"},
            "data": {"S.$": "States.JsonToString($.JSONField)"}
        }
    },
    "ResultPath": "$.PutItemResults",
    "End": true
}
```



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Array construction

```
{
    "AllowedIPs.$": "States.Array('127.0.0.1', '::1', $.SourceIP)"
}
```



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Step lifecycle



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It all starts with an event . . .


```
{
    "ClusterId": "id-1234567890",
    "TableName": "SomeTable",
    "InvokingEvent": {
        "EventBusName": "Application",
        "Source": "Web",
        "Time": "2020-12-11T18:06:24.299Z",
        "DetailType": "Transfer",
        "Detail": {
            "RequestId": "1234567890",
            "FromAccount": "AB1234567890",
            "ToAccount": "ZY0987654321",
            "Amount": "1234.56"
        }
    }
}
```

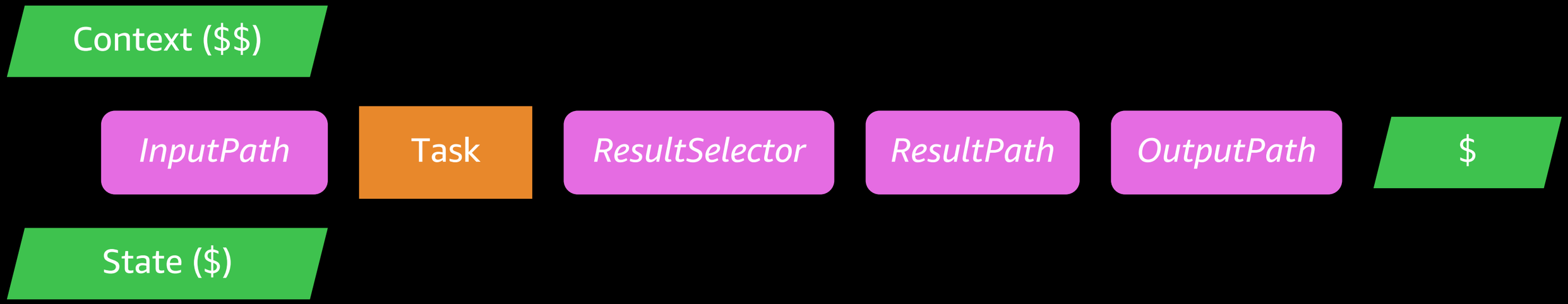
. . . and some context

```
{
    "Execution": {
        "Id": "String",
        "Input": {},
        "StartTime": "Format: ISO 8601"
    },
    "State": {
        "EnteredTime": "Format: ISO 8601",
        "Name": "String",
        "RetryCount": Number
    },
    "StateMachine": {
        "Id": "String"
    },
    "Task": {
        "Token": "String"
    }
}
```

```
{
    "ClusterId": "id-1234567890",
    "TableName": "SomeTable",
    "InvokingEvent": {
        "EventBusName": "Application",
        "Source": "Web",
        "Time": "2020-12-11T18:06:24.299Z",
        "DetailType": "Transfer",
        "Detail": {
            "RequestId": "1234567890",
            "FromAccount": "AB1234567890",
            "ToAccount": "ZY0987654321",
            "Amount": "1234.56"
        }
    }
}
```

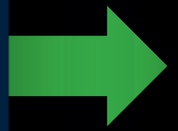
Order of operations

- *InputPath*
- Task state
- *ResultSelector*
- *ResultPath*
- *OutputPath*



“InputPath”: “$.InvokingEvent”


```
{
    "ClusterId": "id-1234567890",
    "TableName": "SomeTable",
    "InvokingEvent": {
        "EventBusName": "Application",
        "Source": "Web",
        "Time": "2020-12-11T18:06:24.299Z",
        "DetailType": "Transfer",
        "Detail": {
            "RequestId": "1234567890",
            "FromAccount": "AB1234567890",
            "ToAccount": "ZY0987654321",
            "Amount": "1234.56"
        }
    }
}
```

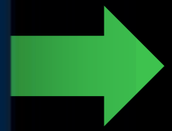




```
{
    "EventBusName": "Application",
    "Source": "Web",
    "Time": "2020-12-11T18:06:24.299Z",
    "DetailType": "Transfer",
    "Detail": {
        "RequestId": "1234567890",
        "FromAccount": "AB1234567890",
        "ToAccount": "ZY0987654321",
        "Amount": "1234.56"
    }
}
```


InputPath | Task | *ResultSelector* | *ResultPath* | *OutputPath*

Task state

```
{
    "EventBusName": "Application",
    "Source": "Web",
    "Time": "2020-12-11T18:06:24.299Z",
    "DetailType": "Transfer",
    "Detail": {
        "RequestId": "1234567890",
        "FromAccount": "AB1234567890",
        "ToAccount": "ZY0987654321",
        "Amount": "1234.56"
    }
}
```



```
{
    "SdkHttpMetadata": {
        "AllHttpHeaders": {
            "Server": [
                "Server"
            ],
            "Connection": [
                "keep-alive"
            ],
            "x-amzn-RequestId": [
                "01edf8c3-fadd-4368-b140-75026b7deae9"
            ],
            "x-amz-crc32": [
                "2745614147"
            ],
            "Content-Length": [
                "2"
            ],
            "Date": [
                "Fri, 11 Dec 2020 19:46:29 GMT"
            ],
            "Content-Type": [
                "application/x-amz-json-1.0"
            ]
        },
        "HttpHeaders": {
            "Connection": "keep-alive",
            "Content-Length": "2",
            "Content-Type": "application/x-amz-json-1.0",
            "Date": "Fri, 11 Dec 2020 19:46:29 GMT",
            "Server": "Server",
            "x-amz-crc32": "2745614147",
            "x-amzn-RequestId": "01edf8c3-fadd-4368-b140-75026b7deae9"
        },
        "HttpStatusCode": 200
    },
    "SdkResponseMetadata": {
        "RequestId": "01edf8c3-fadd-4368-b140-75026b7deae9"
    }
}
```

InputPath | Task | *ResultSelector* | *ResultPath* | *OutputPath*

ResultSelector

```
{
    "EventBusName": "Application",
    "Source": "Web",
    "Time": "2020-12-11T18:06:24.299Z
    "DetailType": "Transfer",
    "Detail": {
        "RequestId": "1234567890",
        "FromAccount": "AB1234567890",
        "ToAccount": "ZY0987654321",
        "Amount": "1234.56"
    }
}
```

```
{
    "ResultSelector": {
        "StatusCode.$": "$.SdkHttpMetadata.HttpStatusCode",
        "RequestId.$": "$.SdkResponseMetadata.RequestId",
        "RequestDate.$": "$.SdkHttpMetadata.HttpHeaders.Date"
    }
}
```



```
{
    "StatusCode": 200,
    "RequestId": "01edf8c3-fadd-4368-b140-75026b7deae9",
    "RequestDate": "Fri, 11 Dec 2020 19:46:29 GMT"
}
```

InputPath | Task | *ResultSelector* | *ResultPath* | *OutputPath*

“ResultPath”: “$.Detail.LockInfo”


```
{
    "EventBusName": "Application",
    "Source": "Web",
    "Time": "2020-12-11T18:06:24.299Z",
    "DetailType": "Transfer",
    "Detail": {
        "RequestId": "1234567890",
        "FromAccount": "AB1234567890",
        "ToAccount": "ZY0987654321",
        "Amount": "1234.56",
        "LockInfo": {
            "StatusCode": 200,
            "RequestId": "01edf8c3-fadd-4368-b140-75026b7deae9",
            "RequestDate": "Fri, 11 Dec 2020 19:46:29 GMT"
        }
    }
}
```


InputPath | Task | *ResultSelector* | *ResultPath* | *OutputPath*

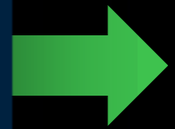
“OutputPath”: “$.Detail”


```
{
    "RequestId": "1234567890",
    "FromAccount": "AB1234567890",
    "ToAccount": "ZY0987654321",
    "Amount": "1234.56",
    "LockInfo": {
        "StatusCode": 200,
        "RequestId": "01edf8c3-fadd-4368-b140-75026b7deae9",
        "RequestDate": "Fri, 11 Dec 2020 19:46:29 GMT"
    }
}
```


InputPath | Task | *ResultSelector* | *ResultPath* | *OutputPath*

Now state is transformed


```
{
    "RequestId": "1234567890",
    "FromAccount": "AB1234567890",
    "ToAccount": "ZY0987654321",
    "Amount": "1234.56",
    "LockInfo": {
        "StatusCode": 200,
        "RequestId": "01edf8c3-fadd-4368-b140-75026b7deae9",
        "RequestDate": "Fri, 11 Dec 2020 19:46:29 GMT"
    }
}
```

State ($)

InputPath | Task | *ResultSelector* | *ResultPath* | *OutputPath*

Handling errors



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“Complex systems run in degraded mode.”



Richard I. Cook, MD

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Retriers

- Task, Parallel, and Map states
- Switch / case statement on *ErrorEquals* value
- *IntervalSeconds* is the number of seconds before first retry
- *MaxAttempts* is the number of retries (may be 0)
- *BackoffRate* is a multiplier

```
{
    "Retry": [
        {
            "ErrorEquals": [ "States.Timeout" ],
            "MaxAttempts": 0
        },
        {
            "ErrorEquals": [ "States.All" ],
            "IntervalSeconds": 3,
            "MaxAttempts": 2,
            "BackoffRate": 1.5
        }
    ]
}
```

Catchers

```
{
    "Catch": [
        {
            "ErrorEquals": ["States.Timeout"],
            "ResultPath": "$.error-info",
            "Next": "RecoveryState"
        },
        {
            "ErrorEquals": ["States.ALL"],
            "Next": "EndMachine"
        }
    ]
}
```

- Task, Parallel, and Map states
- Also known as fallback states
- Scanned in array order when there is an error and no Retrier or all retries have failed
- Switch / case statement on *ErrorEquals* value
- *ResultPath* for storing error
- *Next* defines the next state

Parallelism and concurrency



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Parallelism and concurrency

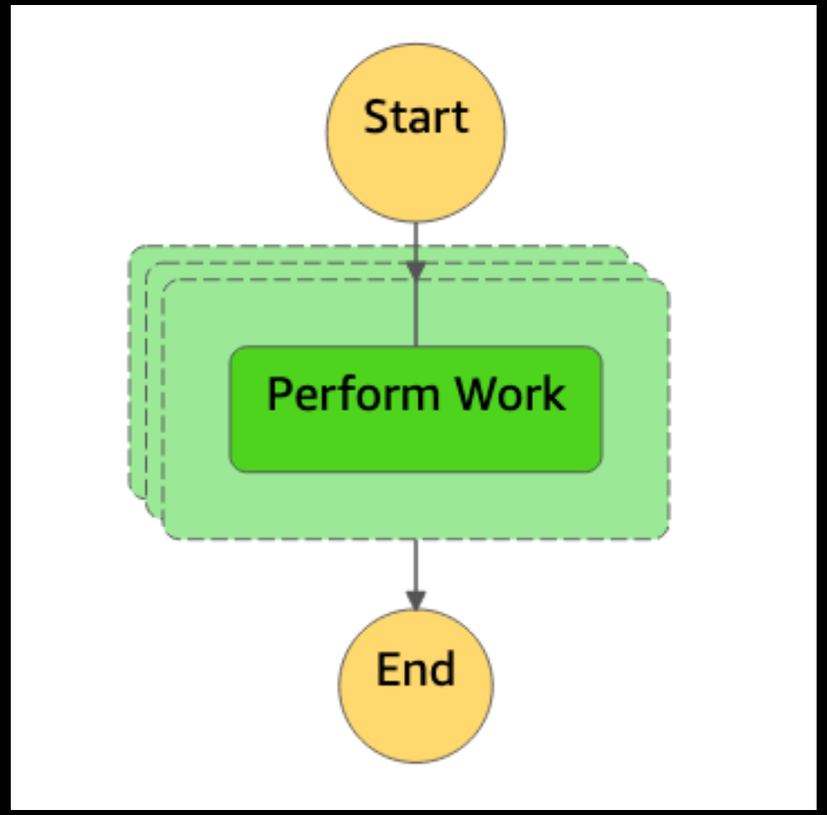
- Parallel invocations
- Dynamic parallelism (Map state)
- Function-native concurrency



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Dynamic parallelism (Map state)

- Total items in *ItemsPath* limited by state limit of 256 KB
- *MaxConcurrency* theoretically limitless if set to 0 (default)
- Practically, host affinity limits concurrent invocations to 40
- *MaxConcurrency* synchronous and sequential when set to 1





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Review

- Amazon States Language improvements
- The lifecycle of a single step
- Handling errors
- Parallelism and concurrency
- Additional resources at s12d.com/svs406



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Thank you!

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