Azure Durable Functions

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About Me

- Co-Leader of .NET Rochester (formerly VDUNY)
- RIT Graduate - BioMedical Computing (2000)
- Working in software for 20+ yrs, primarily .NET & Web
- Part-time Pyrotechnician (23+ yrs)
- Assistant Scoutmaster, Troop 750

Azure Functions

A brief re-cap

Azure Functions

- "Serverless" computing offering for Azure
  - You write the code and upload it; Azure does the rest
- Available in several languages (C#, Java, JavaScript, Python, PowerShell)
- Cross platform development & hosting
  - Windows, MacOS, Linux
- Available in 2 different pricing models
  - Premium Plan (pre-warmed instances always running + scale up)
  - App Service Plan (alongside existing App Service instance w/o added $)
  - Consumption (pay-per-use; generous free allotment; 1M/400,000GB-s)
- Stateless
- Time-limited!
  - (5min; extendable to 10)
- Functions runtime is Open Source on GitHub

Azure Functions Triggers

- **HTTP**
  - web-requests; micro-services
- **Timer**
  - Scheduled runs
- **Azure CosmosDB**
  - New/updated documents
- **Blob storage**
  - New/modified blobs
- **Queue storage**
  - New messages
- **Event Grid**
  - Events via subscriptions/filters
- **Event Hub**
  - High volumes of events
- **Service Bus Queue/Topic**
- **Many others**

Quick Demo

Basic Azure Function

Azure Durable Functions

What is a durable function?

Azure Durable Functions

- Stateful functions in a serverless environment
  - Create workflows using **Orchestrator** functions that invoke single purpose **Activity** functions
  - Stateful Entities using **Entity** functions
- Orchestrators are *not time limited!*
- Language support
  - C#, JavaScript, F#
  - (goal to support same as Functions)

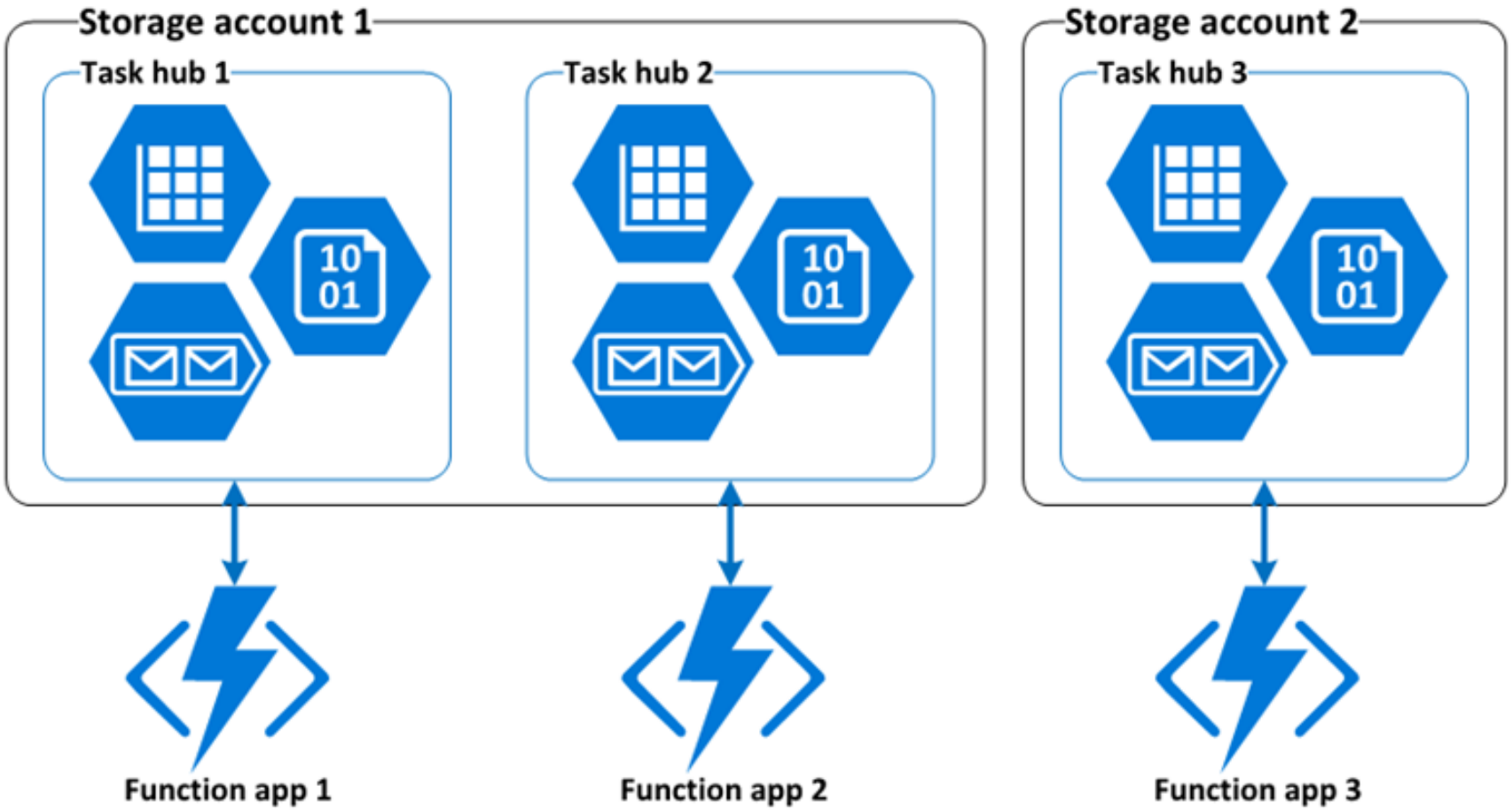
Azure Durable Functions

- Consists of 3 types of functions:
  - **Starter** function(s)
    - Entry point that starts an orchestrator
    - Http, Queue, etc.
    - Can have more than 1 (HTTP & Queue)
  - **Orchestrator** function
    - Main processing loop
    - Must be *deterministic* (no calls to DateTime.Now(), Guid.New(), etc.)
    - Re-entrant (executes multiple times)
    - Composes Activity functions into a workflow
  - **Activity** function(s)
    - 'Units of work' such as calling external services, non-deterministic code, etc.
    - Might be executed more than once; should be *idempotent*

Task Hubs

- *Logical* container for Azure Storage resources
- Consists of:
  - 1+ control queues (based on scaling config params; default of 4)
  - 1 work-item queue
  - 1 history table
  - 1 instances table
  - 1 storage container w/ 1+ lease blobs
  - 1 storage container for large message payloads (if needed)
- Task Hub Name must be unique if sharing a storage account between multiple durable function apps

Task Hubs


Storage account 1
Task hub 1
Task hub 2
Storage account 2
Task hub 3
10
01
Function app 1
Function app 2
Function app 3

Starter Functions

- Entry point for the Orchestrator
- Triggered like a standard Azure Function
- Kicks off the Orchestrator function
- Optionally returns info for monitoring the Orchestrator progress
  - REST service that can be queried given an Instance ID

Sample Starter Function

```
[FunctionName("Function1_HttpStart")]
0 references
public static async Task<HttpResponseMessage> HttpStart(
    [HttpTrigger(AuthorizationLevel.Anonymous, "get", "post")] HttpRequestMessage req,
    [DurableClient] IDurableOrchestrationClient starter,
    ILogger log)
{
    // Function input comes from the request content.
    string instanceId = await starter.StartNewAsync("Function1", null);

    log.LogInformation($"Started orchestration with ID = '{instanceId}'.");

    return starter.CreateCheckStatusResponse(req, instanceId);
}
```

Orchestrator Functions

- Workflow management
  - Which Actions to invoke
  - What order to run them in
  - Invoking *sub*-orchestrations
  - Waiting for external input
- Re-entrant
  - Orchestrator runs multiple times, picking up where it left off each time

Sample Orchestrator Function

```
[FunctionName("Function1")]
0 references
public static async Task<List<string>> RunOrchestrator(
    [OrchestrationTrigger] IDurableOrchestrationContext context)
{
    var outputs = new List<string>();

    // Replace "hello" with the name of your Durable Activity Function.
    outputs.Add(await context.CallActivityAsync<string>("Function1_Hello", "Tokyo"));
    outputs.Add(await context.CallActivityAsync<string>("Function1_Hello", "Seattle"));
    outputs.Add(await context.CallActivityAsync<string>("Function1_Hello", "London"));

    // returns ["Hello Tokyo!", "Hello Seattle!", "Hello London!"]
    return outputs;
}
```

Activity Functions

- Basic 'unit of work' in a workflow
- Can perform network calls, CPU intensive operations, etc.
- Can return data back to the Orchestrator
- Durable Task framework ensure activity will be run ***at least once***
  - Activities should be **idempotent**
    - Multiple invocations should have the same outcome (similar to REST guidelines)

Sample Activity Function

```
[FunctionName("Function1_Hello")]
0 references
public static string SayHello([ActivityTrigger] string name, ILogger log)
{
    log.LogInformation($"Saying hello to {name}.");
    return $"Hello {name}!";
}
```

Quick Demo

Basic Durable Function

Patterns

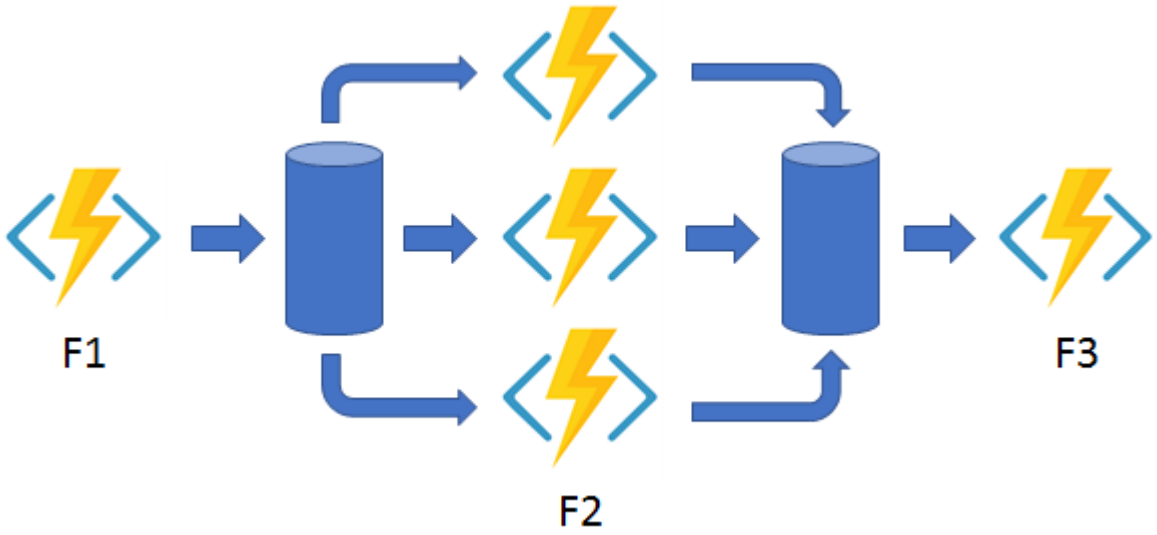
Application patterns made easier with Durable Functions

Supported Application Patterns

- Durable Functions make the following patterns easier:
  - Function Chaining (previous demo)
  - Fan-out/Fan-in
  - Async HTTP APIs
  - Monitoring
  - Human Interaction
  - Aggregator (stateful entities)
  - Etc.

Patterns: Fan-out/in

- Execute a series of Activities in parallel
- Collate results before moving on



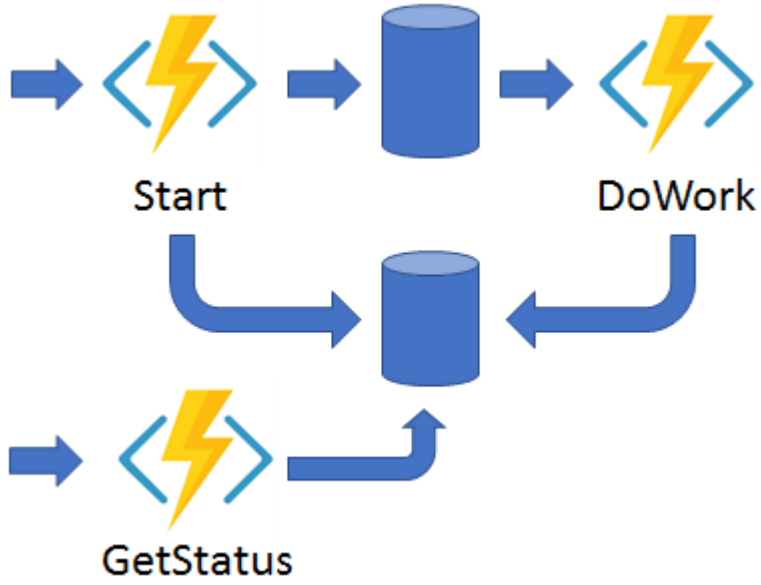
Quick Demo

Fan Out / Fan In Pattern

Async HTTP APIs

- REST API to trigger orchestrations directly
- WebHooks to query the status, cancel, etc.
- HTTP Trigger returns URLS that can be used for this
- Ensure there is an expiration!

POST https://myfunc.azurewebsites.net/orchestrators/DoWork



Quick Demo

Async HTTP APIs

Pattern: Human Interaction

- Pauses the orchestration while waiting for an external event
- REST endpoint for providing the response
- Can be raised from another function
  - `await client.RaiseEventAsync(instanceId, “EventName", eventData);`
- Ensure there is a timeout!

Quick Demo

Human Interaction

Closing Thoughts

- Durable Entities
  - Define operations for reading and updating small pieces of state
  - All operations on a single entity are guaranteed to execute serially
  - Behave like eternal orchestrations
- Cleanup
  - History for orchestrators/entities is maintained in Azure Storage Account (tables, blobs, queues)
  - Manual process currently to clean this up using `DurableOrchestrationClient.PurgeInstanceHistoryAsync()`

Resources

- Documentation
  - https://docs.microsoft.com/en-us/azure/azure-functions/durable/
- Durable Function Quick start
  - https://docs.microsoft.com/en-us/azure/azure-functions/durable/durable-functions-create-first-csharp?pivots=code-editor-visualstudio
- Making sense of Durable Functions
  - https://mikhail.io/2018/12/making-sense-of-azure-durable-functions/
- Understanding Durable Functions
  - Part 1, Part 2, Part 3, Part 4, Part 5, Part 6, Part 7, Part 8, Part 9, Part 10, Part 11, Part 12
- Azure Durable Functions: Before and After
  - https://medium.com/@ThisisZone/azure-durable-functions-before-and-after-b7266d51ed4d