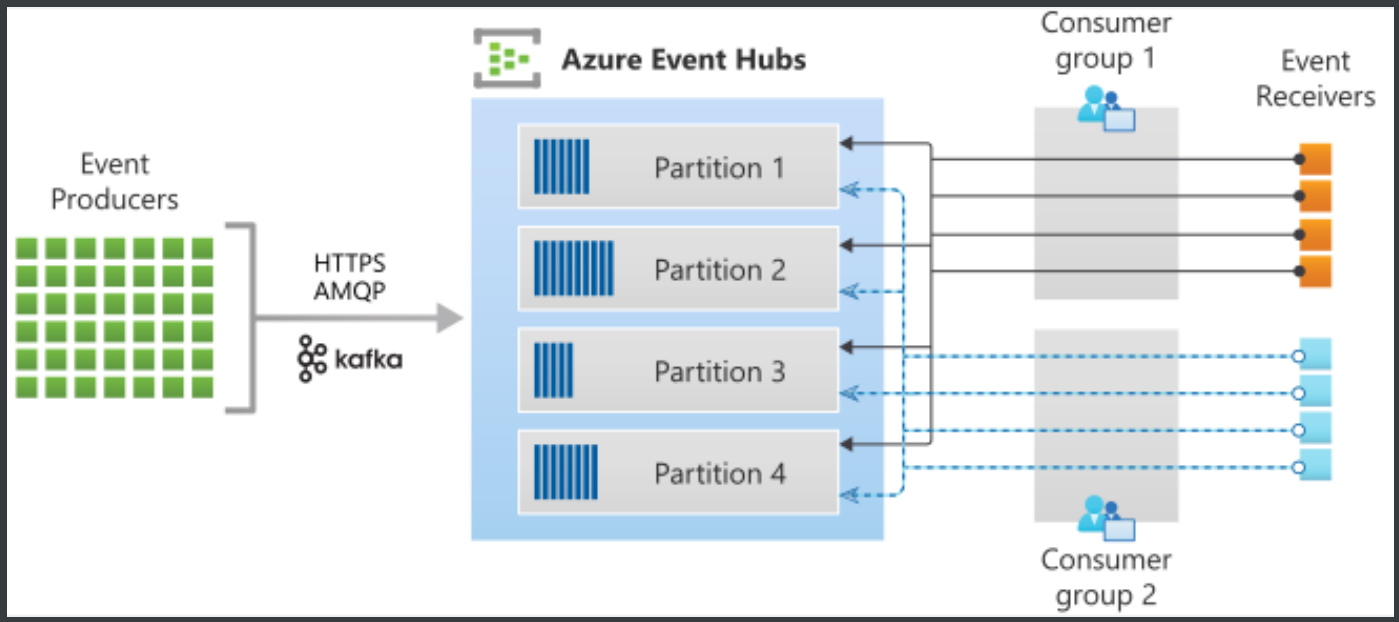
Integration of Services on Azure

Event vs Message

Azure offers following services that assist with delivering events or messages throughout a solution:

- **Azure Event Grid**
- **Azure Event Hubs**
- **Azure Service Bus**

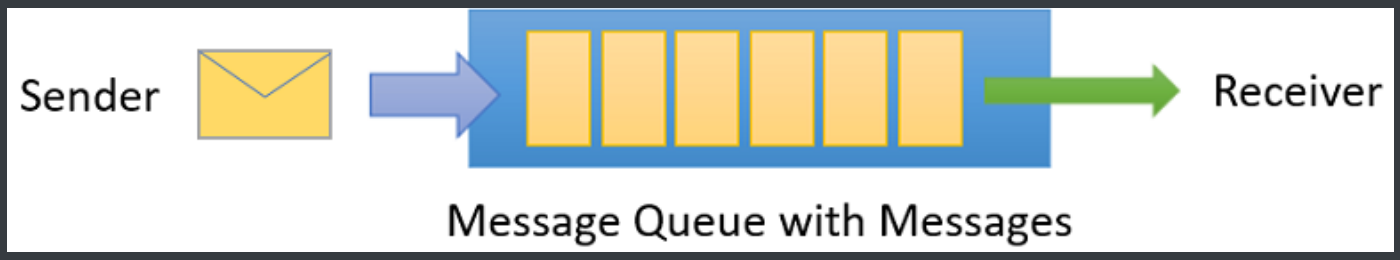
Event

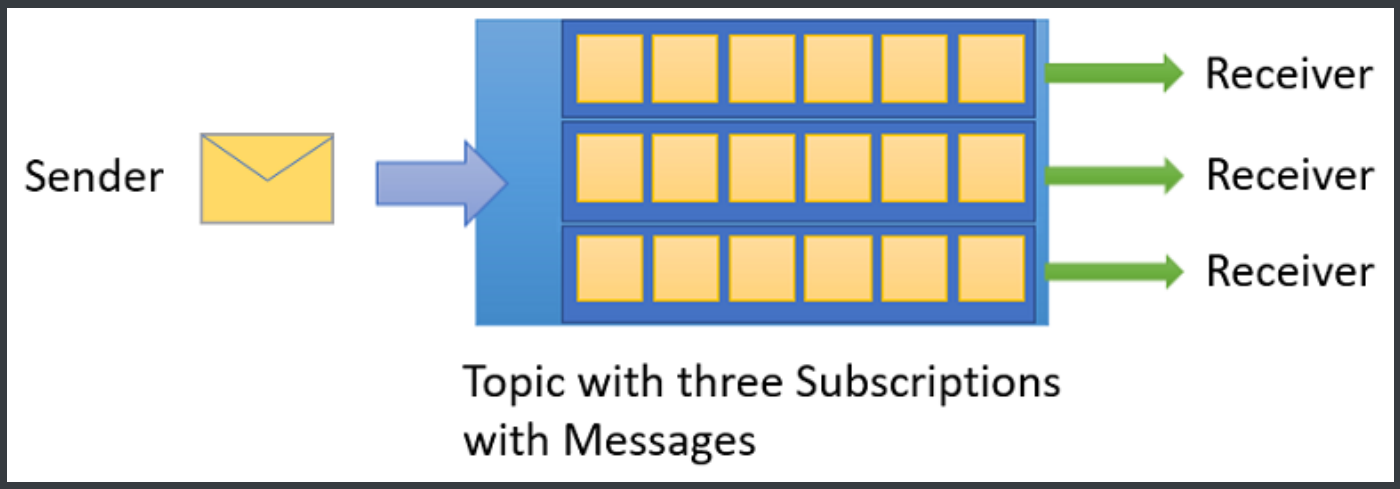


- Lightweight notification of a condition or a state change
- Publisher of the event has no expectation about how the event is handled
- Consumer of the event decides what to do with the notification
- Events can be discrete units or part of a series

- Discrete events report state change and are actionable
- Series events report a condition and are analysable. The events are time-ordered and interrelated

Messages



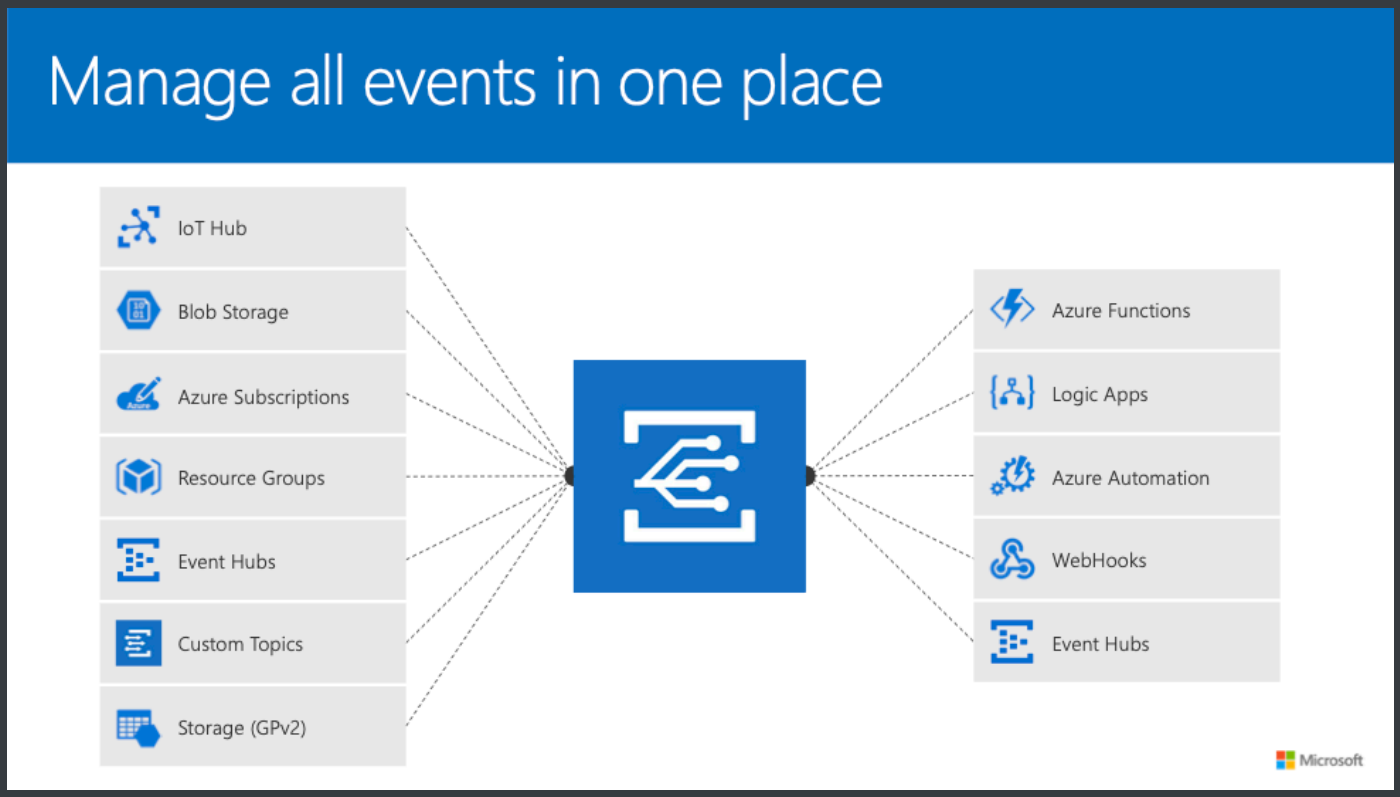


- Raw data produced by a service to be consumed or stored elsewhere
- Contains the data that triggered the message pipeline
- Publisher of the message has an expectation about how the consumer handles the message
- Contract exists between the two sides

Comparison of Messaging Services

Service	Purpose	Type	When to use
Event Grid	Reactive programming	Event distribution (discrete)	React to status changes
Event Hubs	Big data pipeline	Event streaming (series)	Telemetry and distributed data streaming
Service Bus	High-value enterprise messaging	Message	Order processing and financial transactions

EventGrid



- Publishers emit events, but have no expectation about which events are handled
- Subscribers decide which events they want to handle
- Deeply integrated with Azure services and can be integrated with third-party services
- Simplifies event consumption and lowers costs by eliminating the need for constant polling
- Efficiently and reliably routes events from Azure and non-Azure resources

- Distributes the events to registered subscriber endpoints
- Not a data pipeline, and doesn't deliver the actual object that was updated
- Supports Dead-lettering for events that aren't delivered to an endpoint
- It has the following characteristics:
    - Dynamically scalable
    - Low cost
    - Serverless
    - At least once delivery

Events

- Smallest amount of information notifying a change in the system
- **Publishers**
    - Send events to Event Grid
    - Applications, Services Inside Azure Or Outside Azure
- **Sources**
    - Place where the event happens
    - Each Source has one or more Event Types
        - Blob Created Event
        - Message Arrived in Queue Event
        - Azure VM deleted Event
        - Custom events - sent by Applications
            - https://docs.microsoft.com/en-us/azure/event-grid/sdk-overview

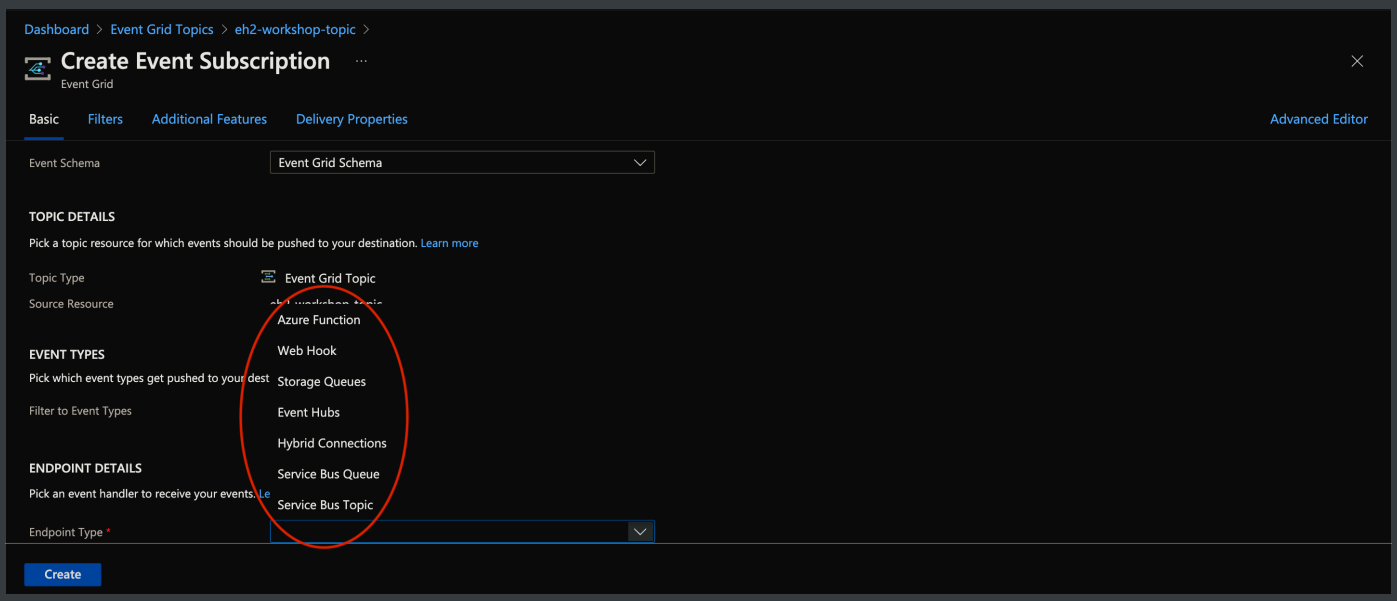
Topics

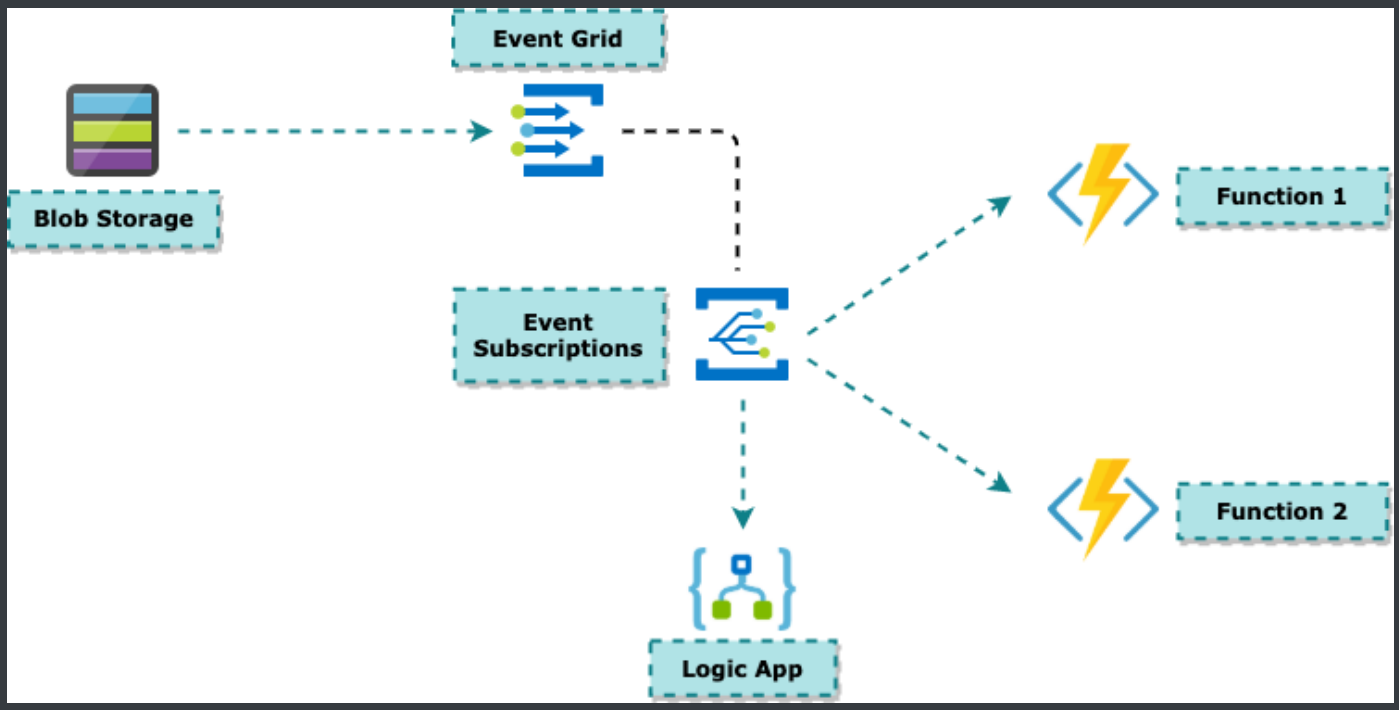
- Provides an endpoint where the Source sends events
- The publisher creates the event grid topic, and decides whether an event source needs one topic or more than one topic
- A Topic is used for a collection of related events. To respond to certain types of events, subscribers decide which topics to subscribe to
- **System topics**

    - Built-in topics provided by Azure services
    - Azure Storage, Azure Event Hubs and Azure Service Bus
- **Custom topics**
    - application and third-party topics
    - Create Topics according to Modules
    - Avoid sending all events to one topic - reduces flexibility, manageability
- **Partner Topic**
    - 3rd party SaaS providers to publish events
    - Their Consumers can subscribe to those events
    - Partner On-boarding - https://docs.microsoft.com/en-us/azure/event-grid/partner-onboarding-overview

Subscribers

- Event handlers; consumes the event
- Azure functions
- Event hubs
- Relay hybrid connections
- Service Bus queues and topics
- Storage queues





Batching

- When using a custom topic, events must always be published in an array
- Recommended to batch several events together per publish to achieve higher efficiency
- Batches can be up to 1 MB. Each event should still not be greater than 1 MB as well

Event Schema

- **Event Grid Event Schema**

```
[
  {
    "topic": string,
    "subject": string,
    "id": string,
    "eventType": string,
    "eventTime": string,
    "data":{
      object-unique-to-each-publisher
    },
```

```
    "dataVersion": string,
    "metadataVersion": string
  }
]
```

- custom topics, the event publisher determines the data object
- top-level data should have the same fields as standard resource-defined events

- **Cloud Event Schema**
  - Defined by Cloud Native foundaion
  - built by several collaborators, including Microsoft

```
{
    "specversion": "1.0",
    "type": "Microsoft.Storage.BlobCreated",
    "source": "/subscriptions/{subscription-
id}/resourceGroups/{resource-
group}/providers/Microsoft.Storage/storageAccounts/{storage-
account}",
    "id": "9aeb0fdf-c01e-0131-0922-9eb54906e209",
    "time": "2019-11-18T15:13:39.4589254Z",
    "subject": "blobServices/default/containers/{storage-
container}/blobs/{new-file}",
    "dataschema": "#",
    "data": {
        "api": "PutBlockList",
        "clientRequestId": "4c5dd7fb-2c48-4a27-bb30-
5361b5de920a",
        "requestId": "9aeb0fdf-c01e-0131-0922-9eb549000000",
        "eTag": "0x8D76C39E4407333",
        "contentType": "image/png",
        "contentLength": 30699,
        "blobType": "BlockBlob",
```

```
            "url":
    "https://gridtesting.blob.core.windows.net/testcontainer/{new-
    file}",
            "sequencer":
    "00000000000000000000000000009924000000000c41c18",
            "storageDiagnostics": {
                "batchId": "681fe319-3006-00a8-0022-9e7cde000000"
            }
        }
    }
```

Input schema	Output schema
CloudEvents format	CloudEvents format
Event Grid format	CloudEvents format
Event Grid format	Event Grid format

Event Delivery

- **Filtering**

```
"filter": {
  "includedEventTypes": [
    "Microsoft.Resources.ResourceWriteFailure",
    "Microsoft.Resources.ResourceWriteSuccess"
  ]
}
```

  - **Subject filtering**
    - create subjects for your events that make it easy for subscribers to know whether they're interested in the event.
    - Subscribers use the subject to filter and route events
    - The path enables subscribers to narrowly or broadly filter events

```
    "filter": {
      "subjectBeginsWith":
    "/blobServices/default/containers/mycontainer/log",
      "subjectEndsWith": ".jpg"
    }
```

- **Advanced filtering**
  - operator type - The type of comparison.
  - key - The field in the event data that you're using for filtering. It can be a number, boolean, string, or an array.
  - values - The value or values to compare to the key

```
"advancedFilters": [{
    "operatorType": "StringContains",
    "key": "data.key1",
    "values": [
        "microsoft",
        "azure"
    ]
}]
```

```
"advancedFilters": [
    {
        "operatorType": "StringContains",
        "key": "Subject",
        "values": [
            "/providers/microsoft.devtestlab/",
            "/providers/Microsoft.Compute/virtualMachines/"
        ]
    }
]
```

OR Filtering

```
"advancedFilters": [
    {
        "operatorType": "StringContains",
        "key": "Subject",
        "values": [
            "/providers/microsoft.devtestlab/"
        ]
    },
    {
        "operatorType": "StringContains",
        "key": "Subject",
        "values": [
            "/providers/Microsoft.Compute/virtualMachines/"
        ]
    }
]
```

AND Filtering

- **Delivery & Retry**
  - provides durable delivery
  - decides whether it should retry the delivery, dead-letter the event, or drop the event based on the type of the error
  - can't be fixed with retries (for example, if the endpoint is deleted), EventGrid will either perform dead-lettering on the event or drop the event if dead-letter isn't configured

Endpoint Type	Error codes
Azure Resources	400 Bad Request, 413 Request Entity Too Large, 403 Forbidden
Webhook	400 Bad Request, 413 Request Entity Too Large, 403 Forbidden, 404 Not Found, 401 Unauthorized

- Event Grid waits 30 seconds for a response after delivering a message. After 30 seconds, if the endpoint hasn't responded, the message is queued for retry. Event Grid uses an exponential backoff retry policy for event delivery
- Event Grid retries delivery on the following schedule on a best effort basis:
    - 10 seconds
    - 30 seconds
    - 1 minute
    - 5 minutes
    - 10 minutes
    - 30 minutes
    - 1 hour
    - 3 hours
    - 6 hours
    - Every 12 hours up to 24 hours
- If the endpoint responds within 3 minutes, Event Grid will attempt to remove the event from the retry queue on a best effort basis but duplicates may still be received.

- **Disaster Recovery**
    - Automatic geo disaster recovery (GeoDR) of meta-data not only for new, but all existing domains, topics, and event subscriptions. If an entire Azure region goes down, Event Grid will already have all of your event-related infrastructure metadata synced to a paired region. Your new events will begin to flow again with no intervention by you.
    - Disaster recovery is measured with two metrics:
        - **Recovery Point Objective (RPO)**: the minutes or hours of data that may be lost.
        - **Recovery Time Objective (RTO)**: the minutes or hours the service may be down.
    - Event Grid's automatic failover has different RPOs and RTOs for your metadata (event subscriptions etc.) and data (events)
        - **Recovery point objective (RPO)**
            - **Metadata RPO**: zero minutes. Anytime a resource is created in Event Grid, it's instantly replicated across regions. When a failover occurs, no

metadata is lost
    - **Data RPO**: If your system is healthy and caught up on existing traffic at the time of regional failover, the RPO for events is about 5 minutes
  - **Recovery time objective (RTO)**
    - **Metadata RTO**: Though generally it happens much more quickly, within 60 minutes, Event Grid will begin to accept create/update/delete calls for topics and subscriptions
    - **Data RTO**: Like metadata, it generally happens much more quickly, however within 60 minutes, Event Grid will begin accepting new traffic after a regional failover

Security

- **Authorizarion**
  - **Bult-in Roles**

Role	Description
Event Grid Subscription Reader	Lets you read Event Grid event subscriptions.
Event Grid Subscription Contributor	Lets you manage Event Grid event subscription operations.
Event Grid Contributor	Lets you create and manage Event Grid resources.
Event Grid Data Sender	Lets you send events to Event Grid topics.

  - **Custom roles**

```
{
  "Name": "Event grid read only role",
  "Id": "7C0B6B59-A278-4B62-BA19-411B70753856",
  "IsCustom": true,
  "Description": "Event grid read only role",
  "Actions": [
```

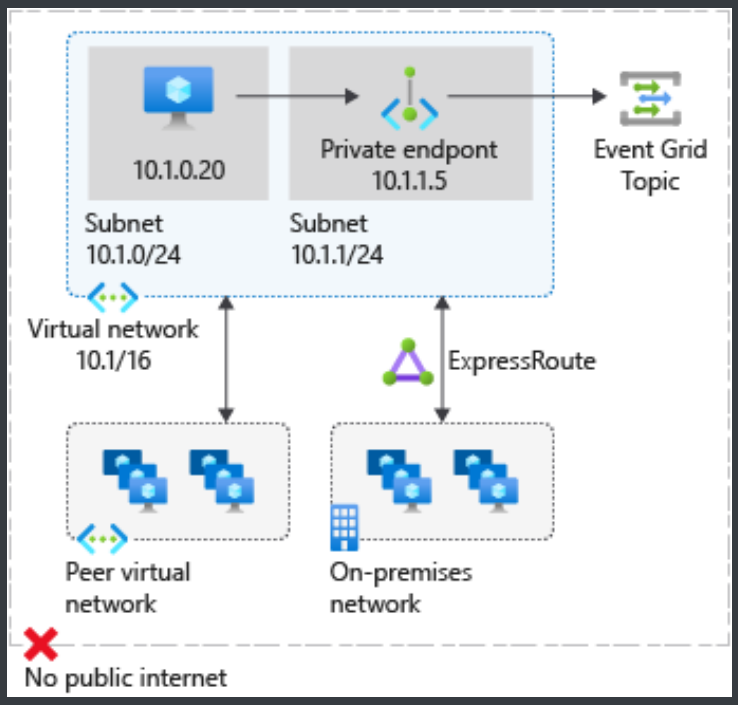
```
      "Microsoft.EventGrid/*/read"
    ],
    "NotActions": [
    ],
    "AssignableScopes": [
      "/subscriptions/<Subscription Id>"
    ]
  }
```

```
az role definition create --role-definition <role-file-name.json>
```

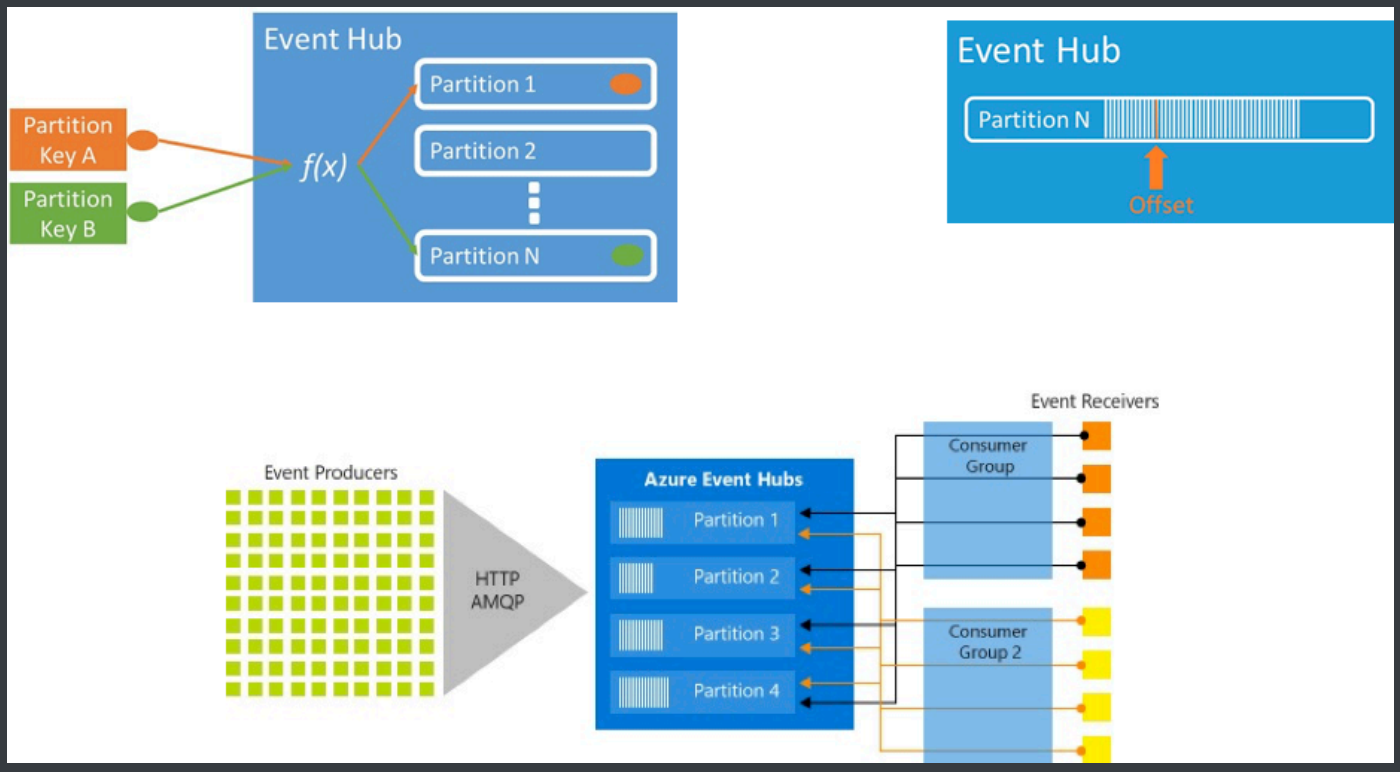
- **Authentication**

Authentication method	Supported handlers	Description
Access key	Event HubsService BusStorage QueuesRelay Hybrid ConnectionsAzure FunctionsStorage Blobs (Deadletter)	Access keys are fetched using Event Grid service principal's credentials. The permissions are granted to Event Grid when you register the Event Grid resource provider in their Azure subscription.
Managed System Identity & Role-based access control	Event HubsService BusStorage QueuesStorage Blobs (Deadletter)	Enable managed system identity for the topic and add it to the appropriate role on the destination. For details, see Use system-assigned identities for event delivery.
Bearer token authentication with Azure AD protected webhook	Webhook	See the Authenticate event delivery to webhook endpoints section for details..
Client secret as a query parameter	Webhook	See the Using client secret as a query parameter section for details.

- **Network Security**
  - **IP firewall**
  - **Private endpoints**
    - allow ingress of events directly from your virtual network to your topics and domains securely over a private link without going through the public internet



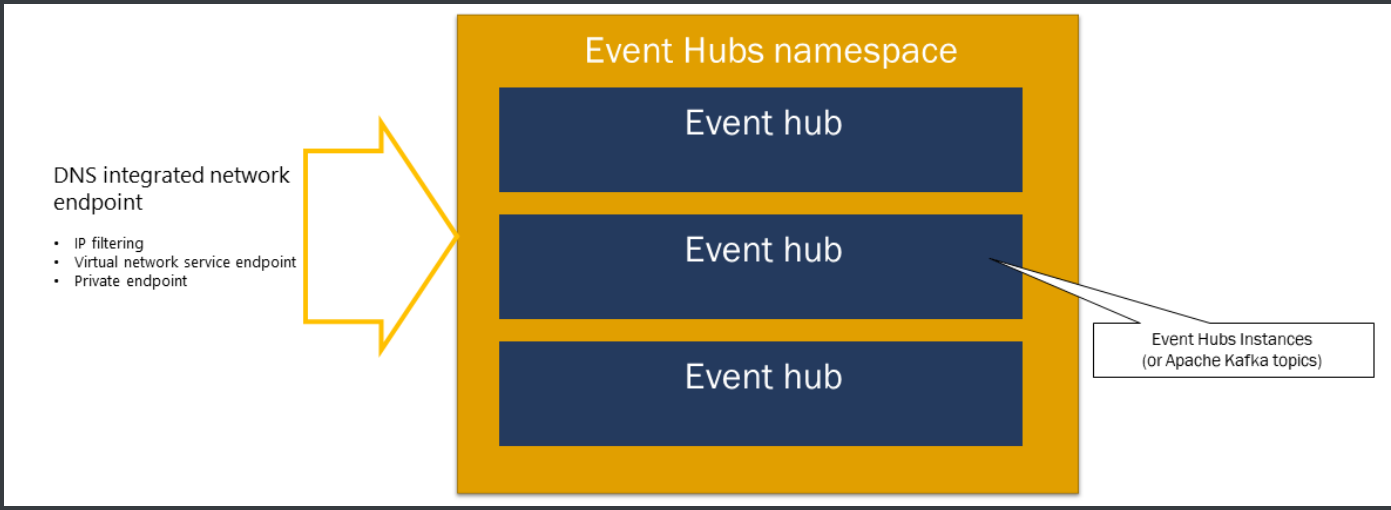
Event Hub



- Facilitates the capture, retention, and replay of telemetry and event stream data
- Data can come from many concurrent sources

- Single solution that enables rapid data retrieval for real-time processing as well as repeated replay of stored raw data
- Can capture the streaming data into a file for processing and analysis
- Available either as data streams or bundled event batches
- Characteristics:
  - Low Latency
  - Capable of receiving and processing millions of events per second
  - At least once delivery

Namespace



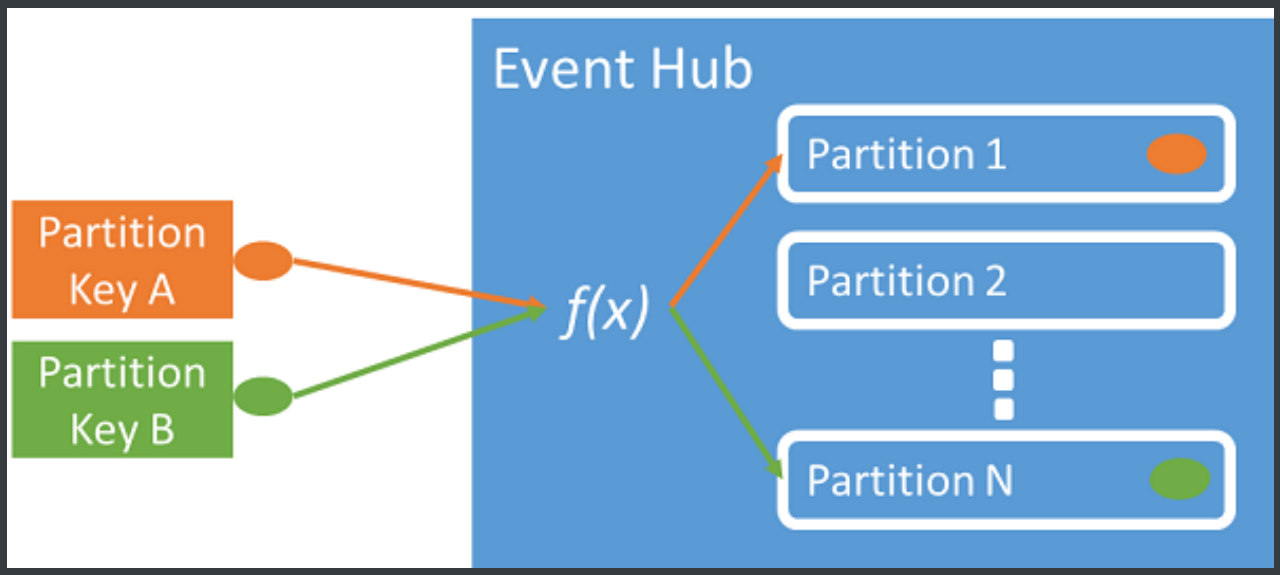
Event publishers

Sends data to an Event Hub - **Producer**

- Any entity that sends data to an event hub is an event producer, or *event publisher*
- Event publishers can publish events using -
  - HTTPS
  - AMQP 1.0
  - Kafka 1.0 and later

- Event publishers use a Shared Access Signature (SAS) token to identify themselves to an event hub, and can have a unique identity, or use a common SAS token

- **Publishing an event**
  - Event Hubs ensures that all events sharing a partition key value are delivered in order, and to the same partition
  - If partition keys are used with publisher policies, then the identity of the publisher and the value of the partition key must match. Otherwise, an error occurs



- **Publisher Policy**
  - Event Hubs enables granular control over event publishers through *publisher policies*
  - Publisher policies are run-time features designed to facilitate large numbers of independent event publishers

```
//<my namespace>.servicebus.windows.net/<event hub
name>/publishers/<my publisher name>
```

- **Capture**
  - Automatically capture the streaming data in Event Hubs and save it to either a Blob storage account or an Azure Data Lake Service account
  - Enable Capture from the Azure portal, and specify a minimum size and time window to perform the capture

- **Partitions**
  - Ordered sequence of events that is held in an event hub
  - As newer events arrive, they are added to the end of this sequence
  - Can be thought of as a *commit log*
  - Event Hubs retains data for a configured retention time that applies across all partitions in the event hub
  - Events expire on a time basis; you cannot explicitly delete them. Because partitions are independent and contain their own sequence of data, they often grow at different rates
- **Event Retention**
  - Published events are removed from an Event Hub based on a configurable, timed-based retention policy:
    - The **default** value and **shortest** possible retention period is **1 day (24 hours)**.
    - For Event Hubs **Standard**, the maximum retention period is **7 days**.
    - For Event Hubs **Premium** and **Dedicated**, the maximum retention period is **90 days**.
    - If you change the retention period, it applies to all messages including messages that are already in the event hub.

Event Consumers

- Any entity that reads event data from an event hub is an *event consumer*
- All Event Hubs consumers connect via the AMQP 1.0 session and events are delivered through the session as they become available
- Client does not need to poll for data availability

- **Consumer Groups**
  - Publish/subscribe mechanism of Event Hubs is enabled through *consumer groups*
  - A consumer group is a view (*state, position, or offset*) of an entire event hub
  - Enable multiple consuming applications to each have a separate view of the event stream and to read the stream independently at their own pace and with their own offsets
- **Stream offsets**
  - Position of an event within a partition
  - Byte numbering of the event

    - Enables an event consumer (reader) to specify a point in the event stream from which they want to begin reading events
- **Checkpointing**
    - Process by which readers mark or commit their position within a partition event sequence
    - Checkpointing is the responsibility of the consumer and occurs on a per-partition basis within a consumer group
    - For each consumer group, each partition reader must keep track of its current position in the event stream, and can inform the service when it considers the data stream complete

Tiers

Feature	Basic	Standard	Premium	Dedicated
Tenancy	Multi-tenant	Multi-tenant	Multi-tenant with resource isolation	Exclusive single tenant
Private link	N/A	Yes	Yes	Yes
Customer-managed key (Bring your own key)	N/A	N/A	Yes	Yes
Capture	N/A	Priced separately	Included	Included
Dynamic Partition scale out	N/A	N/A	Yes	Yes
Ingress events	Pay per million events	Pay per million events	Included	Included

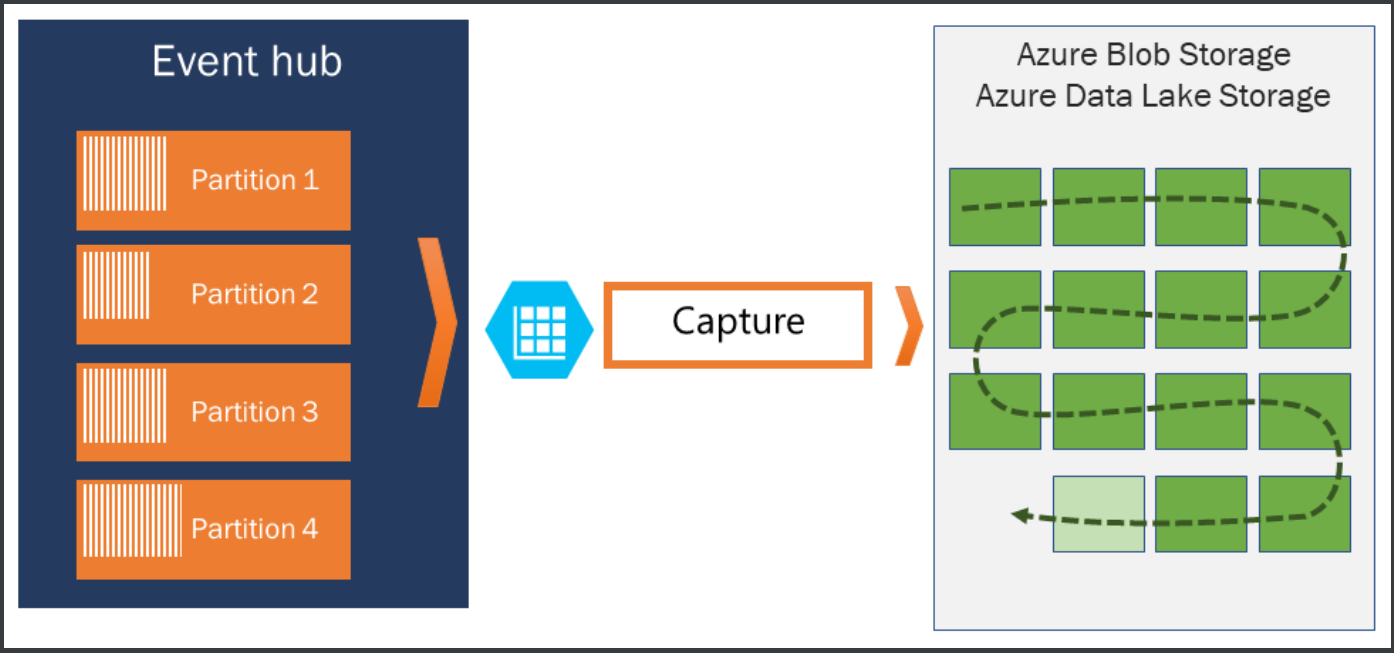
- **Basic** and **Standard**
- **Dedicated**
    - *Event Hubs clusters* offer single-tenant deployments for customers with the most demanding streaming needs

- guaranteed 99.99% SLA and is available only on our Dedicated pricing tier
- Namespaces and event hubs created within the Dedicated cluster include all features of the premium offering and more, but without any ingress limits. It also includes the popular Event Hubs Capture feature at no additional cost. This feature allows automatically batch and log data streams to *Azure Storage* or *Azure Data Lake*.
- Clusters are provisioned and billed by **Capacity Units (CUs)**, a pre-allocated amount of CPU and memory resources. Y1, 2, 4, 8, 12, 16 or 20 CUs for each cluster can be purchased.The effective ingest and stream throughput per PU will depend on various factors, including:
  - Number of producers and consumers
  - Payload shape
  - Egress rate

- **Premium**
  - Designed for high-end streaming scenarios that require elastic, superior performance with predictable latency
  - The performance is achieved by providing reserved compute, memory, and storage resources, which minimize cross-tenant interference in a managed multi-tenant PaaS environment.
  - Replicates every event to three replicas, distributed across Azure *availability zones* where available, and all replicas are synchronously flushed to the underlying fast storage before the send operation is reported as completed
  - Events that are not read immediately or that need to be re-read later can be retained up to 90 days, transparently held in an availability-zone redundant storage tier. Events in both the fast storage and retention storage tiers are encrypted; in Event Hubs Premium, the encryption keys can be BYOK
  - Dynamic partition scale-up
  - The Premium offering is billed by **Processing Units (PUs)** which correspond to a share of isolated resources (*CPU, Memory, and Storage*) in the underlying infrastructure

- In comparison to Dedicated offering, since Event Hubs Premium provides isolation inside a very large multi-tenant environment that can shift resources quickly, it can scale far more elastically and quicker and PUs can be dynamically adjusted. Therefore, Event Hubs Premium will often be a more cost effective option for mid-range (<120MB/sec) throughput requirements, especially with changing loads throughout the day or week, when compared to Event Hubs Dedicated
- 1, 2, 4, 8 and 16 - Processing Units for each namespace can be purchased. Since Event Hubs Premium is a capacity-based offering, the achievable throughput is not set by a throttle as it is in Event Hubs Standard, but depends on the work you ask Event Hubs to do, similar to Event Hubs Dedicated. The effective ingest and stream throughput per PU will depend on various factors, including:
  - Number of producers and consumers
  - Payload size
  - Partition count
  - Egress request rate
  - Usage of Event Hubs Capture, Schema Registry, and other advanced features

Capture Events



Security

- **Authorizarion**
  - **Built-In Roles**

Role	Description
Azure Event Hubs Data owner	Use this role to give complete access to Event Hubs resources.
Azure Event Hubs Data sender	Use this role to give the send access to Event Hubs resources.
Azure Event Hubs Data receiver	Use this role to give the consuming/receiving access to Event Hubs resources.

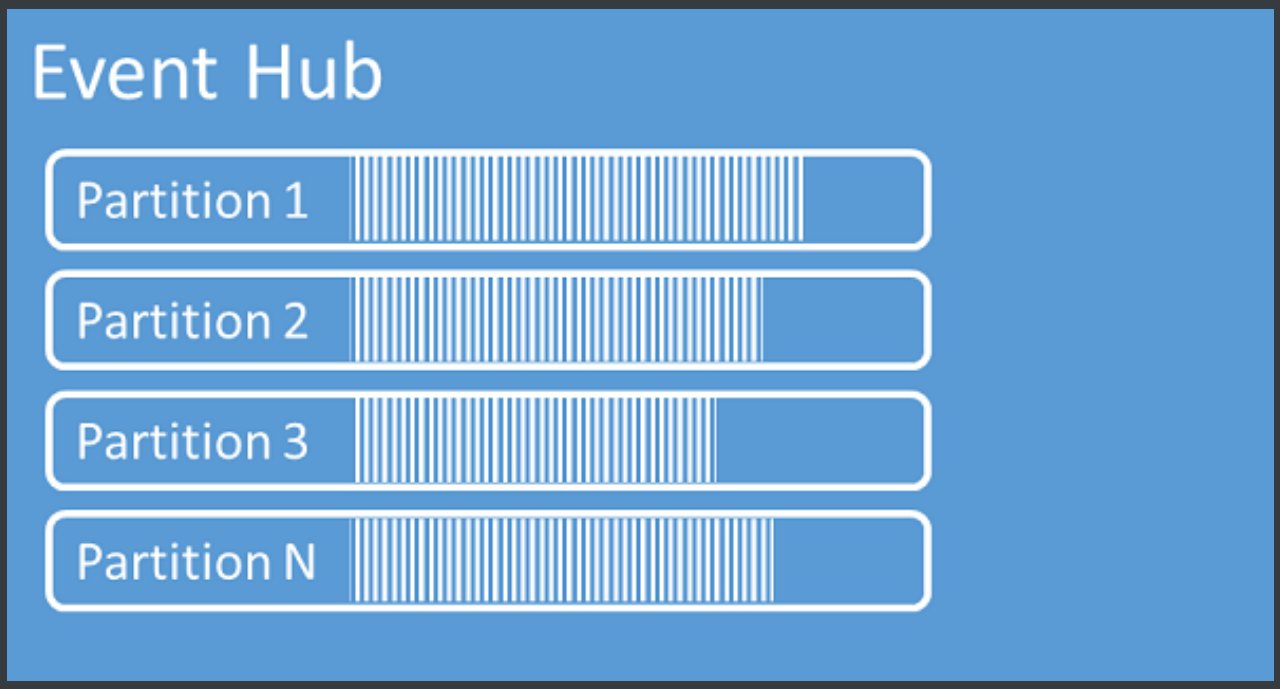
- **Authentication**
  - Authenticate from an Application - registered in Azure AD
  - Authenticate with *Managed Identities*
  - Authenticate with *Shared Access Signature* (*SAS token*)
- **Network Security**
  - **IP firewall**
  - **Service Endpoints**
  - **Private endpoints**

Scalability

- **Throughput units** (*Standard*)
  - Throughput units are pre-purchased units of capacity. 1 TU lets you:
    - **Ingress**: Up to 1 MB per second or 1000 events per second (whichever comes first).
    - **Egress**: Up to 2 MB per second or 4096 events per second.
- **Processing units** (*Premium*)
  - Resource Isolation at the CPU and Memory
  - 1, 2, 4, 8 or 16 *Processing Units* for each Event Hubs can be purchased
- **Capacity Units (CUs)** (*Dedicated*)

- A pre-allocated amount of CPU and Memory resources
- 1, 2, 4, 8, 12, 16 or 20 *Capacity Units* can be purchased. Factors:
  - Number of Producers and Consumers
  - Payload shape
  - Egress rate

- **Partitions**



- **Advantages of using partitions**
  - Capacity of a single process limited
  - Partitions adds more processes

    - Multiplying the throughput capacity
  - **Number of partitions**
    - Pricing depends on TU, PU or CU
    - Choose at least as many partitions as you expect that are required during the peak load
    - Can not be changed later
  - **Mapping of events to partitions**
    - Partition key to map incoming event data into specific partitions
    - Related events together in the same Partition
    - Publisher is only aware of its ***partition key, not the partition***
    - Decoupling of Key and Partition; separate concerns of downstream processing

Availability & Consistency

Availability

- Spreads the risk of failures of individual machines or even complete racks across clusters that span multiple failure domains within a DC
- Transparent failure detection and failover mechanisms
- Service will continue to operate within the assured service-levels
- Without noticeable interruptions when such failures occur
- With *availability zones* enabled, the outage risk is further spread across three physically separated facilities
- Service has enough capacity reserves to instantly cope up with the complete, catastrophic loss of the entire facility
- If Client application sends events to an event hub without specifying a partition, events are automatically distributed among partitions. If a partition isn't available for some reason, events are distributed among the remaining partitions
- Greatest amount of up time. For use cases that require the maximum up time, this model is preferred instead of sending events to a specific partition

Consistency

- If the ordering of events is important, a client application sends events to a specific partition so that the ordering is preserved
- When a consumer application consumes these events from the partition, they are read

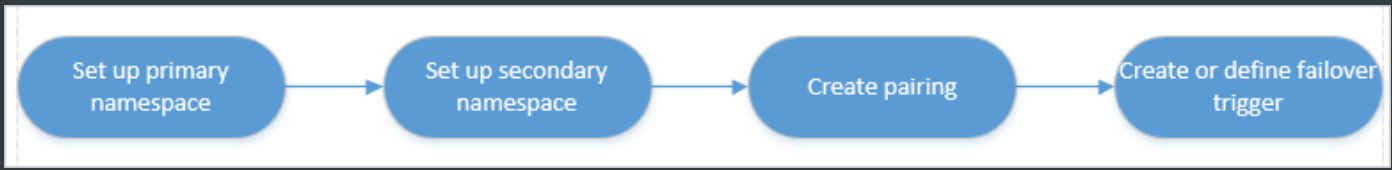
in order

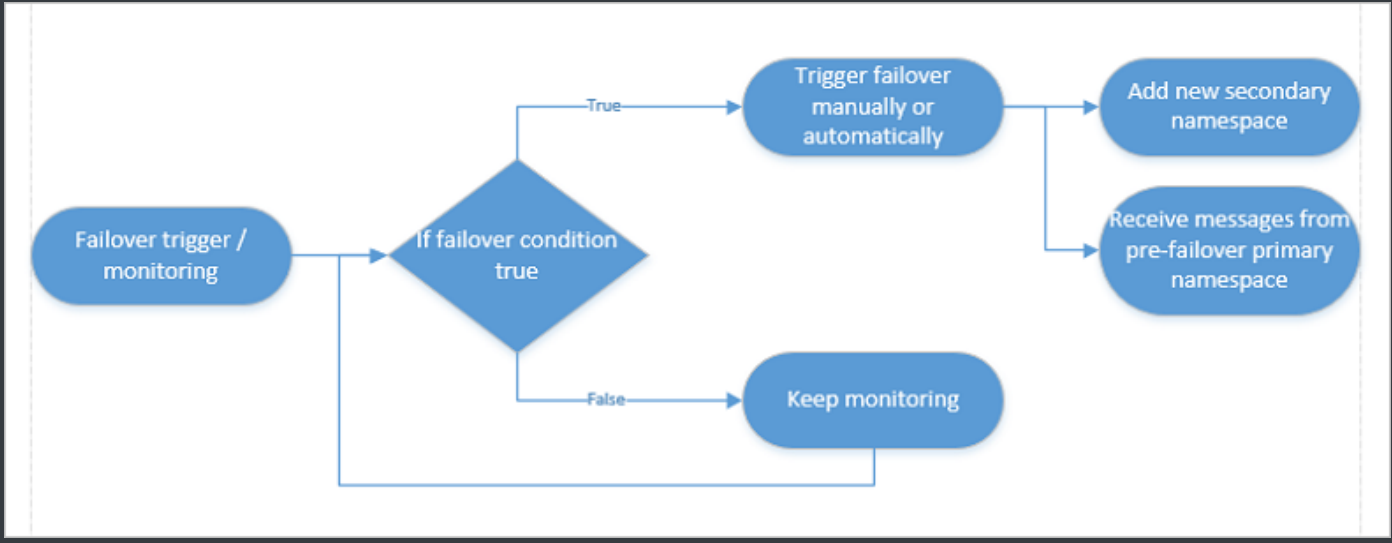
- If the particular partition to which you are sending is unavailable, you will receive an error response. As a point of comparison, if you don't have an affinity to a single partition, the Event Hubs service sends your event to the next available partition.

Point to Note

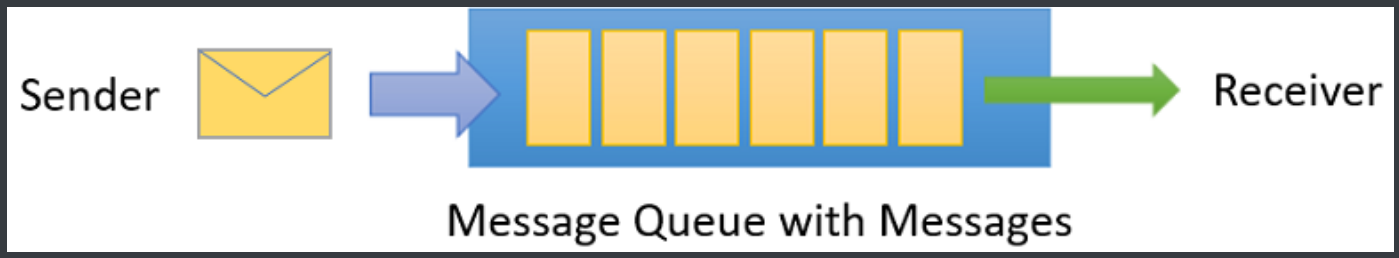
- If high availability is most important, don't target a specific partition (using partition ID/key). Using partition ID/key downgrades the availability of an event hub to partition-level
- Choose between availability (no partition ID/key) and consistency (pinning events to a specific partition)

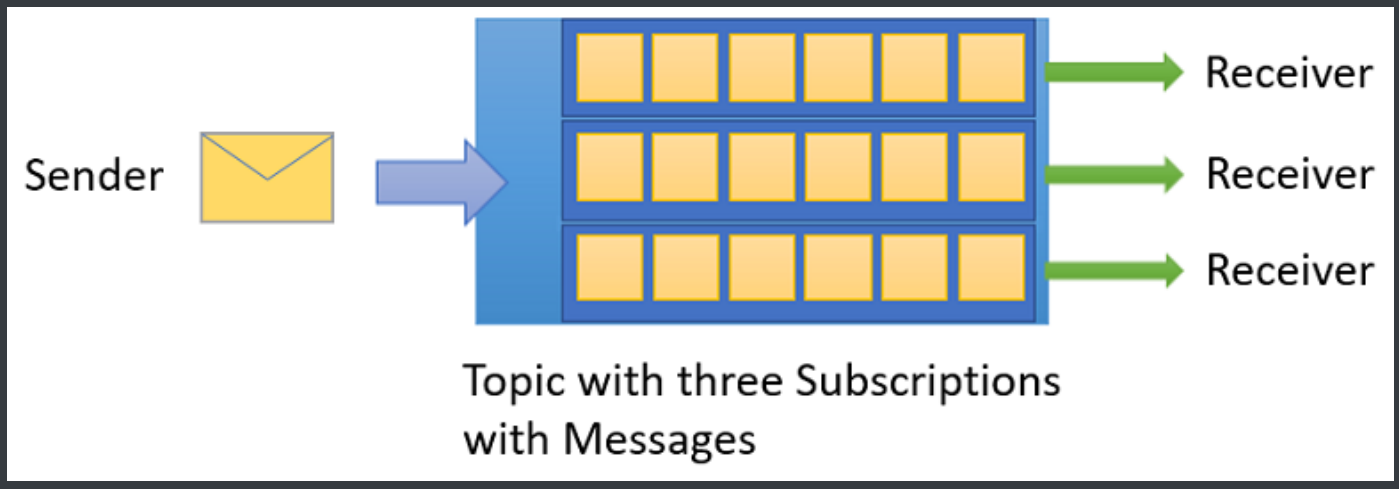
Geo-disaster recovery





Service Bus





- Intended for traditional enterprise applications which require transactions, ordering, duplicate detection, and instantaneous consistency
- Enables cloud-native applications to provide reliable state transition management for business processes
- Facilitates highly secure communication across hybrid cloud solutions and can connect existing on-premises systems to cloud solutions
- Brokered messaging system. It stores messages in a "broker" (for example, a queue) until the consuming party is ready to receive the messages
- Available either as data streams or bundled event batches
- It has the following characteristics:
  - Reliable asynchronous message delivery (enterprise messaging as a service) that requires polling
  - Advanced messaging features like FIFO, batching/sessions, transactions, dead-lettering, temporal control, routing and filtering, and duplicate detection
  - At least once delivery
  - Optional in-order delivery

Queues

- Offer *First In, First Out* (FIFO) message delivery to one or more competing consumers
- Receivers typically receive and process messages in the order in which they were added to the queue, and only one message consumer receives and processes each message
- Producers (senders) and consumers (receivers) do not have to be sending and receiving messages at the same time, because messages are stored durably in the queue
- Producer does not have to wait for a reply from the consumer in order to continue to process and send messages
- Related benefit is *load levelling* which enables producers and consumers to send and receive messages at different rates

Topics and subscriptions

- Provide a one-to-many form of communication, in a *publish/subscribe* pattern
- Useful for scaling to large numbers of recipients, each published message is made available to each subscription registered with the topic
- Messages are sent to a topic and delivered to one or more associated subscriptions

Service Bus – Reliability

Throttling

- Throttling from an external system on which Service Bus depends
- Throttling occurs from interactions with storage and compute resources
- Code must read the error and halt any retries of the message for at least 10 seconds. Since the error can happen across pieces of the customer application, it is expected that each piece independently executes the retry logic
- The code can reduce the probability of being throttled by enabling partitioning on a queue or topic

Issue for an Azure dependency

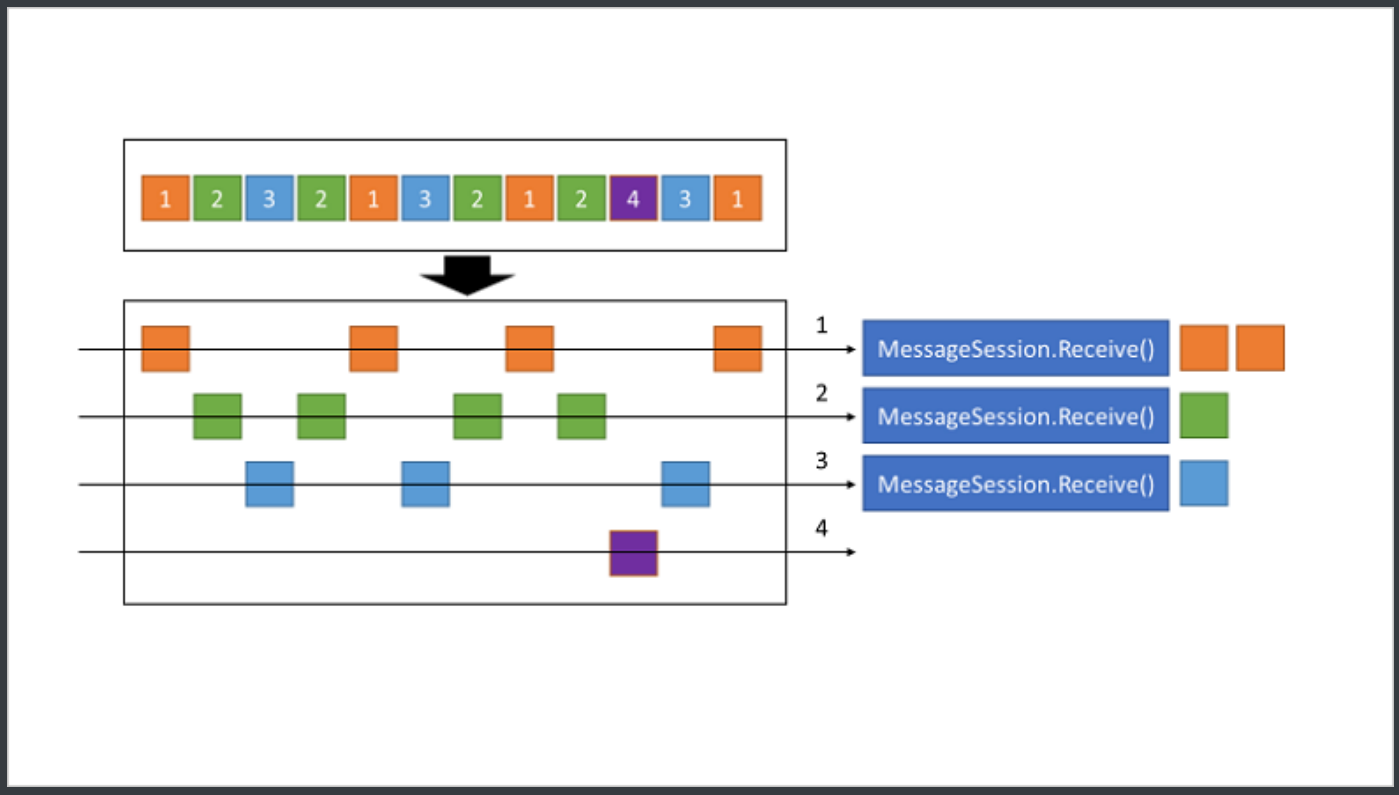
- Issue for a system on which Service Bus depends. For example, a given part of storage

can encounter issues
- To work around these types of issues, Service Bus regularly investigates and implements mitigations
- Due to the nature of the mitigation, a sent message can take up to 15 minutes to appear in the affected queue or subscription and be ready for a receive operation

Service Bus failure on a single subsystem

- Failure of Service Bus on single subsystem. In this situation, a compute node can get into an inconsistent state and must restart itself, causing all entities it serves to load balance to other nodes. This in turn can cause a short period of slow message processing
- The client application generates a *System.TimeoutException* or *MessagingException* exception. Service Bus contains a mitigation for this issue in the form of automated client retry logic. Once the retry period is exhausted and the message is not delivered

Message Sessions



Duplicate detection

Topic filters and actions

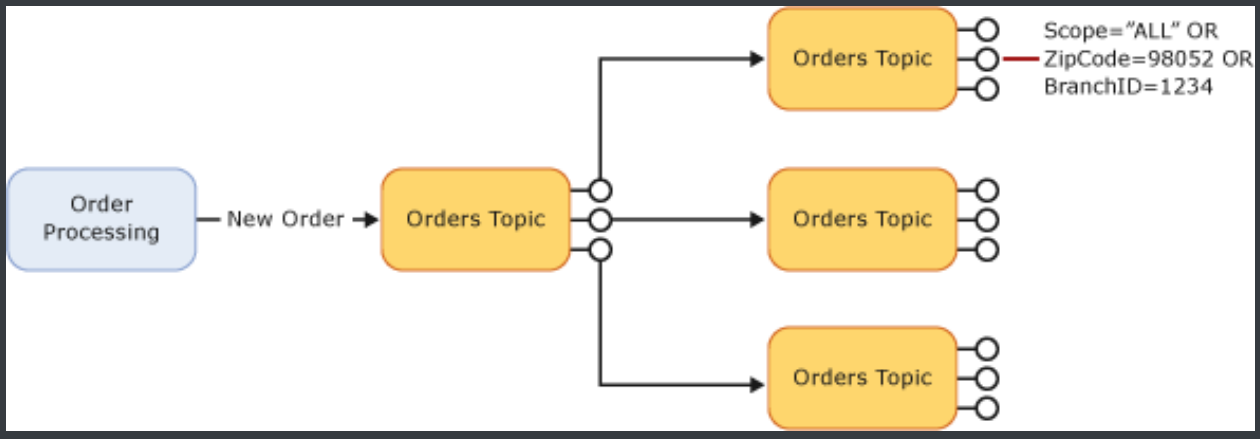
Message browsing

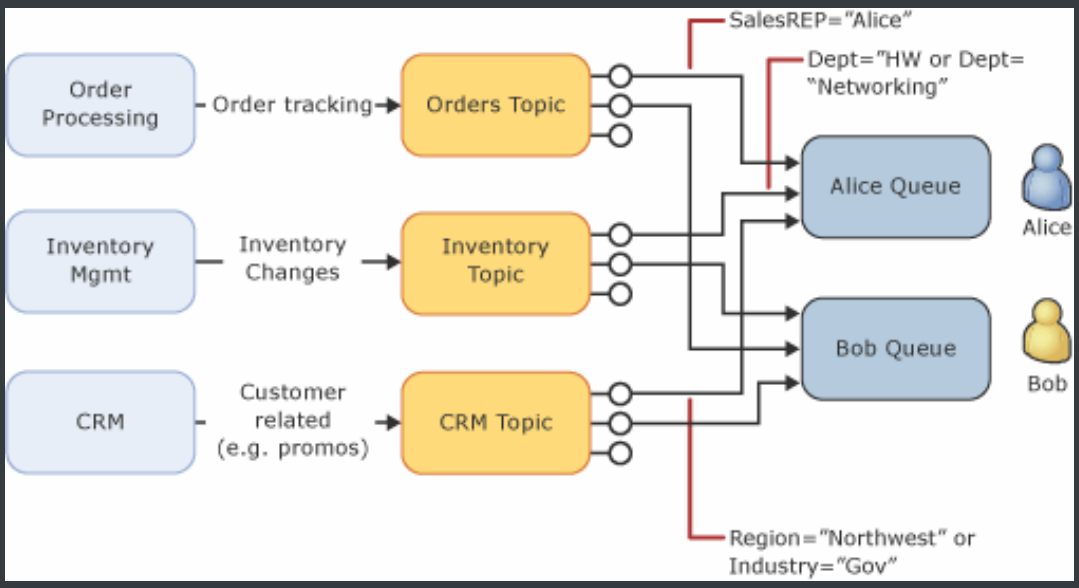
- Dead-lettered messages
- Expired messages
- Locked messages

Message Deferral

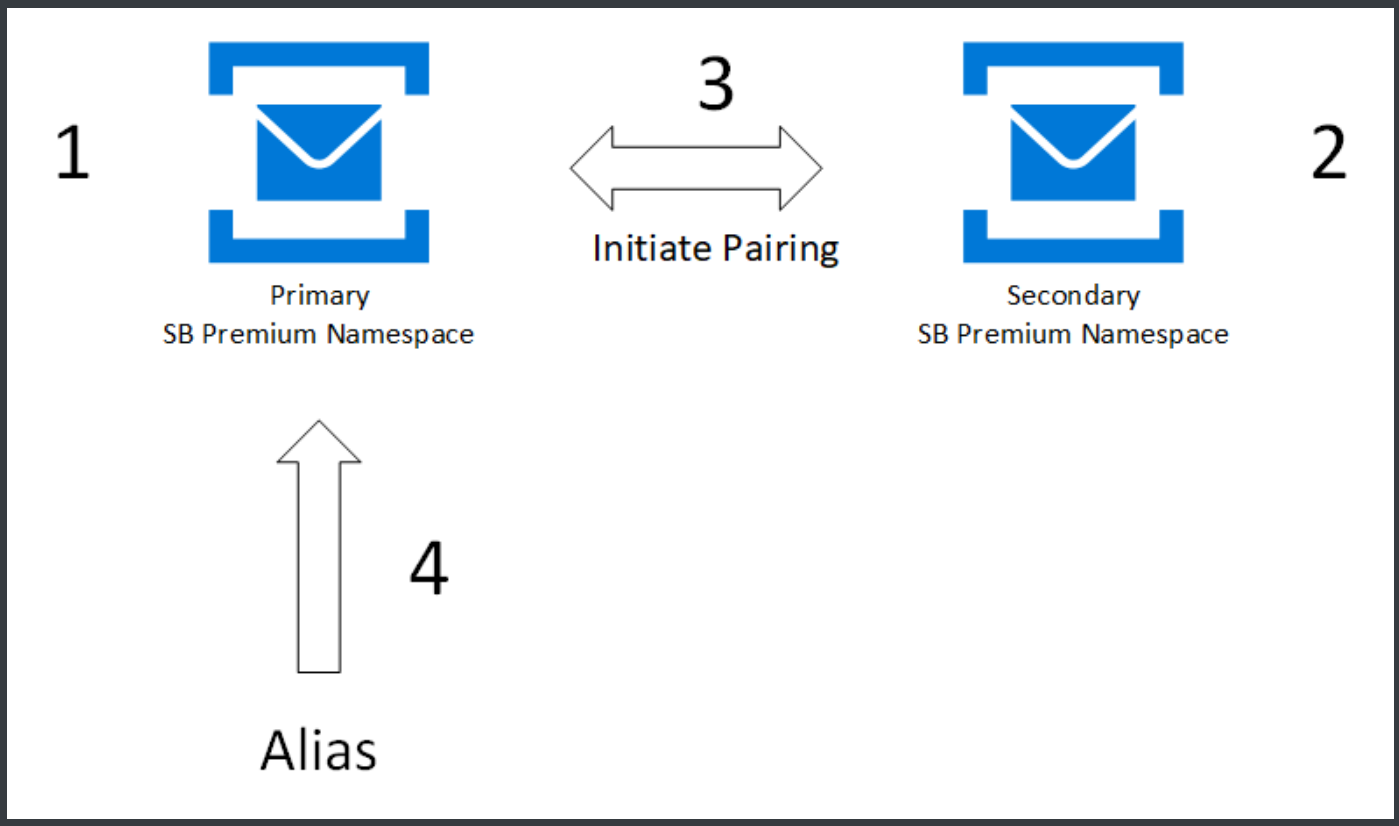
Prefetch Messages

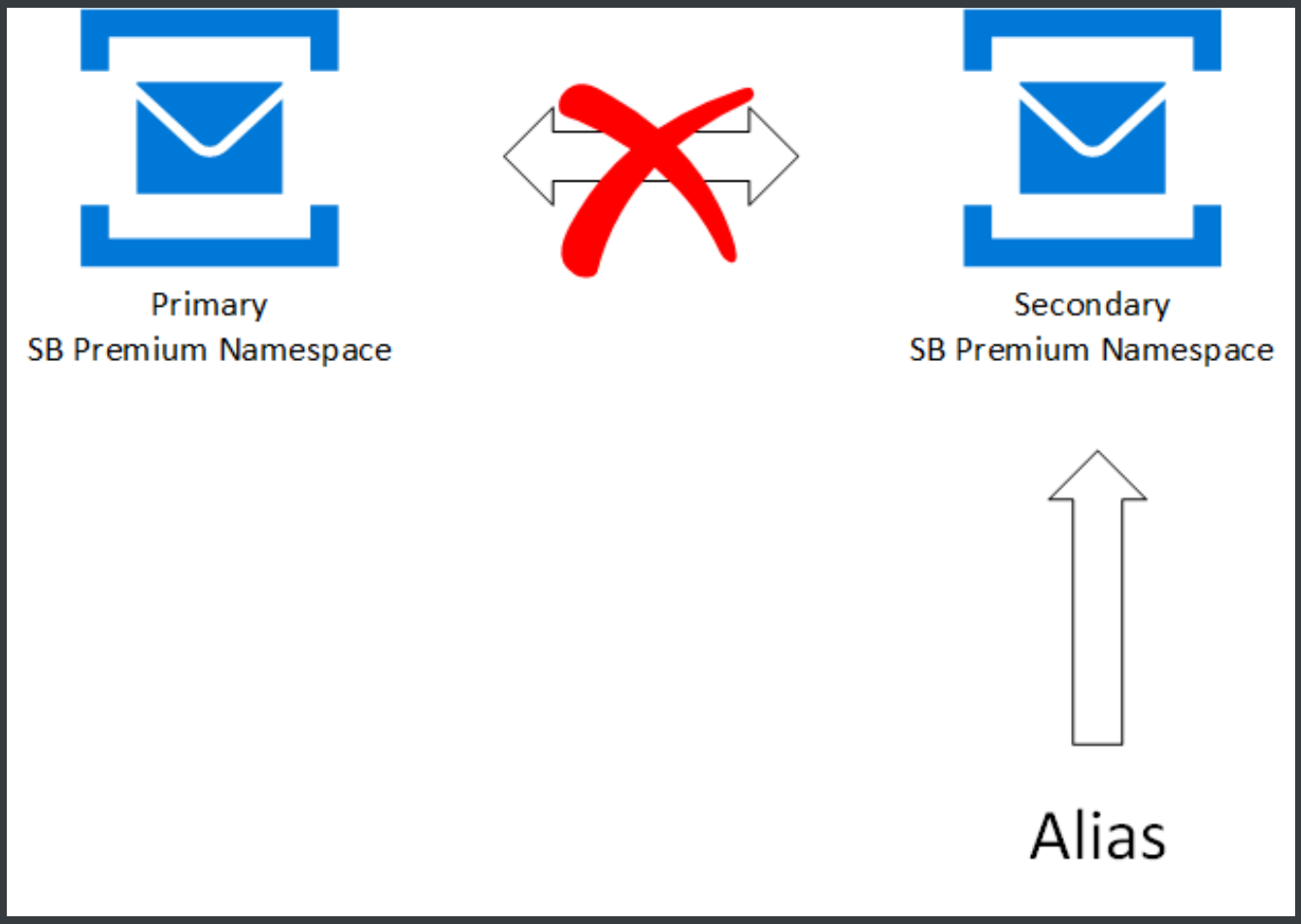
Auto-forwarding





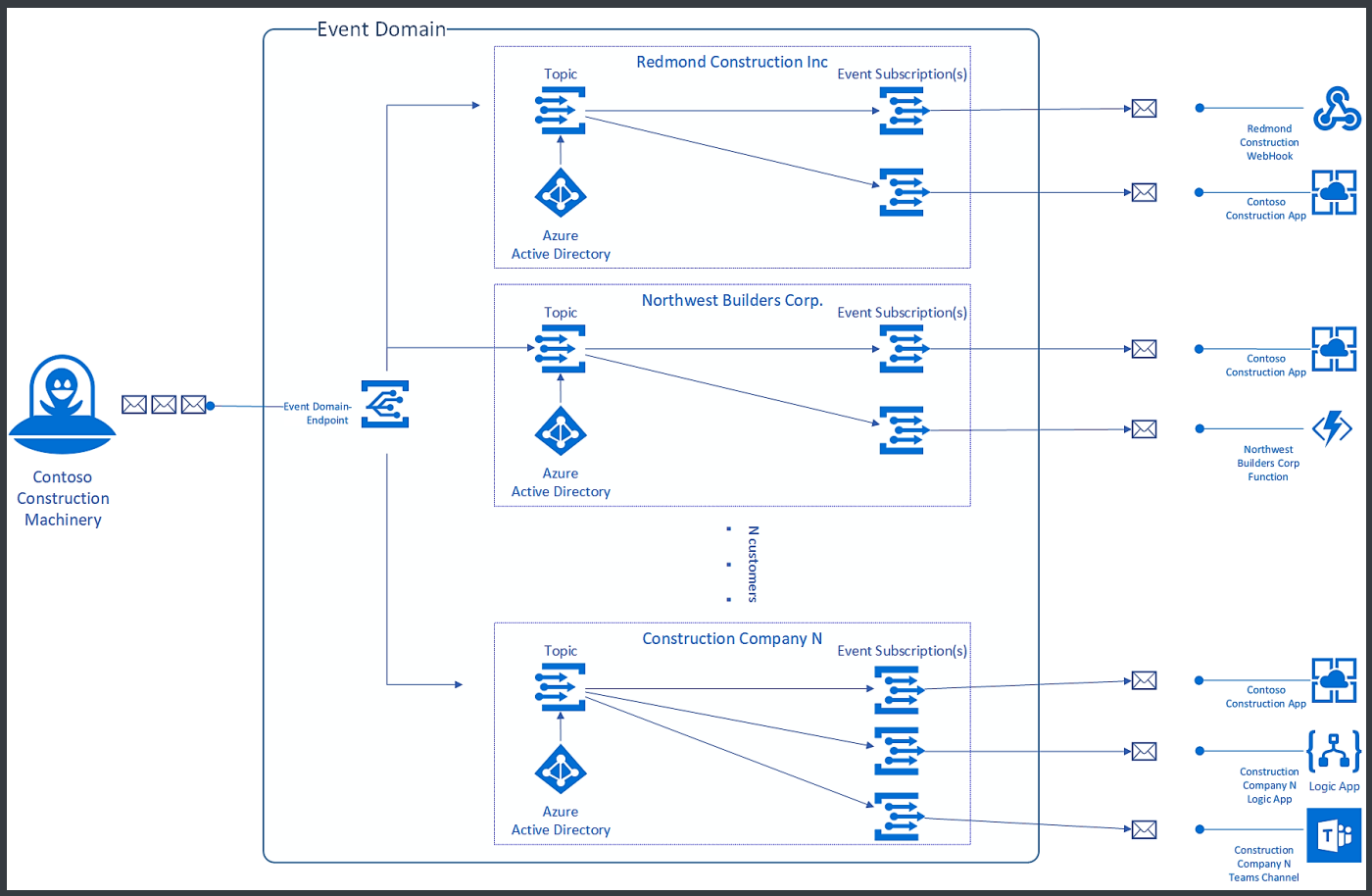
Service Bus – Paired namespaces





- Supports scenarios in which a Service Bus entity or deployment within a data center becomes unavailable
- To maintain application availability during an outage, Service Bus users can use two separate namespaces, preferably in separate data centers, to host their messaging entities
    - **Primary namespace**: The namespace with which your application interacts, for send and receive operations
    - **Secondary namespace**: The namespace that acts as a backup to the primary namespace. Application logic does not interact with this namespace
    - **Failover interval**: The amount of time to accept normal failures before the application switches from the primary namespace to the secondary namespace
- Paired namespaces support *send availability*. Send availability preserves the ability to send messages. To use send availability, your application must meet the following requirements:
    - Messages are only received from the primary namespace
    - Messages sent to a given queue or topic might arrive out of order
    - Messages within a session might arrive out of order. This is a break from normal functionality of sessions. This means that your application uses sessions to logically group messages
    - Session state is only maintained on the primary namespace
    - The primary queue can come online and start accepting messages before the secondary queue delivers all messages into the primary queue.

Use Cases


Event Domain
Redmond Construction Inc
Topic
Event Subscription(s)
Azure
Active Directory
Redmond
Construction
WebHook
Contoso
Construction App
Northwest Builders Corp.
Topic
Event Subscription(s)
Azure
Active Directory
Contoso
Construction App
Northwest
Builders Corp
Function
N customers
Construction Company N
Topic
Event Subscription(s)
Azure
Active Directory
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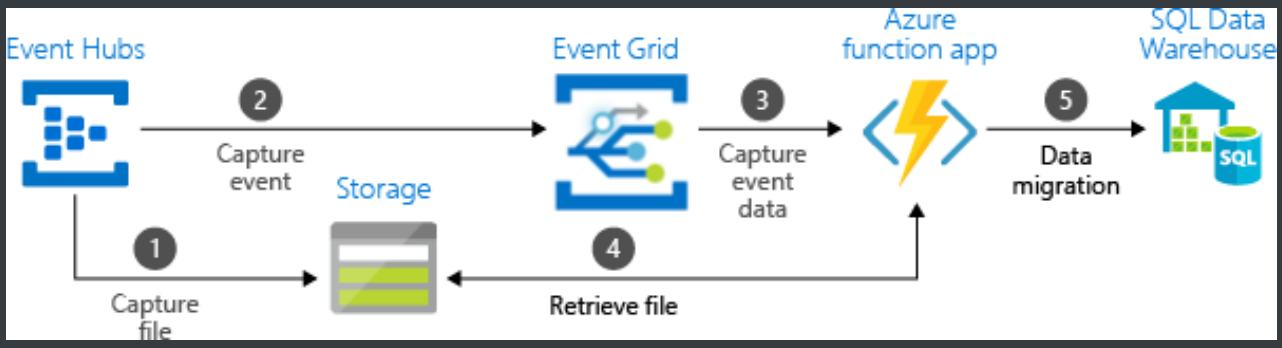
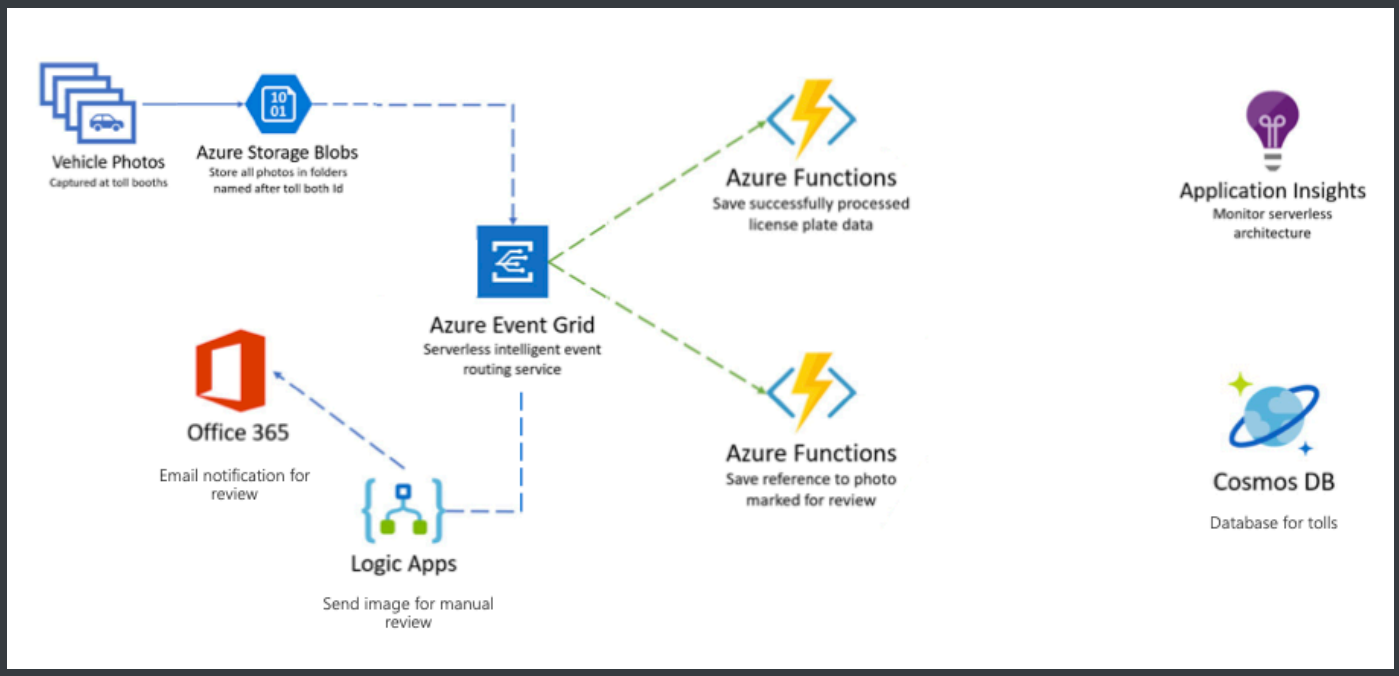
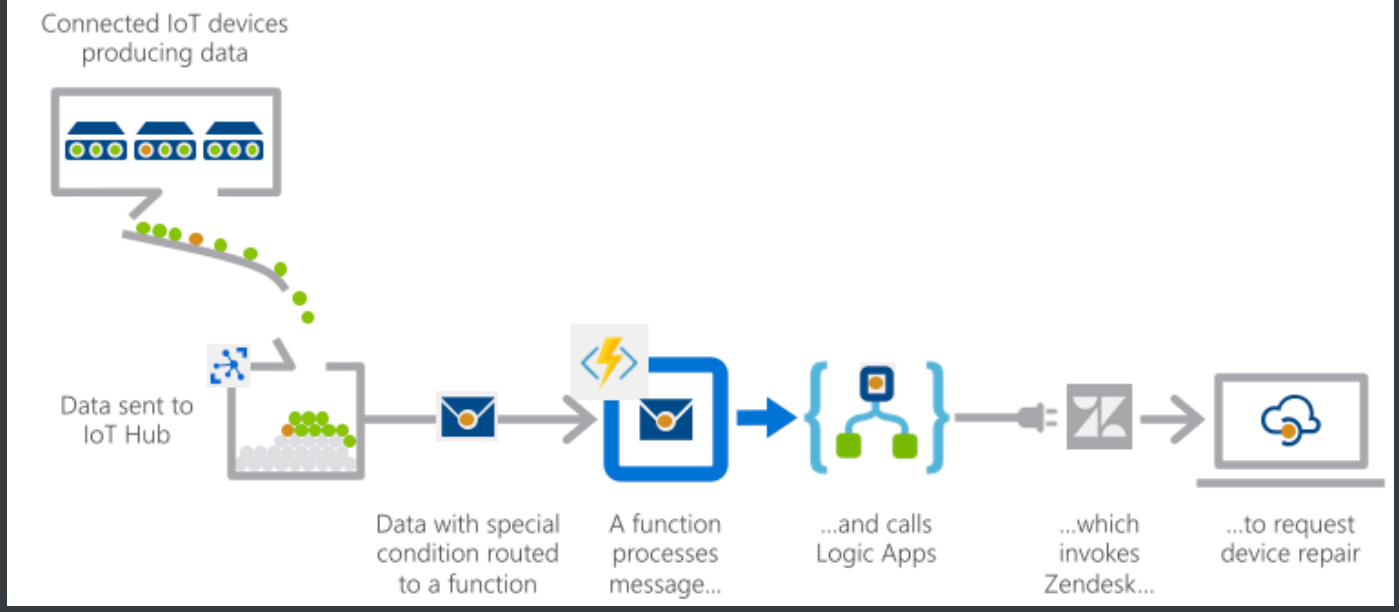
Logic App
Logic App
Construction
Company N
Teams Channel
Contoso
Construction
Machinery
Event Domain-
Endpoint

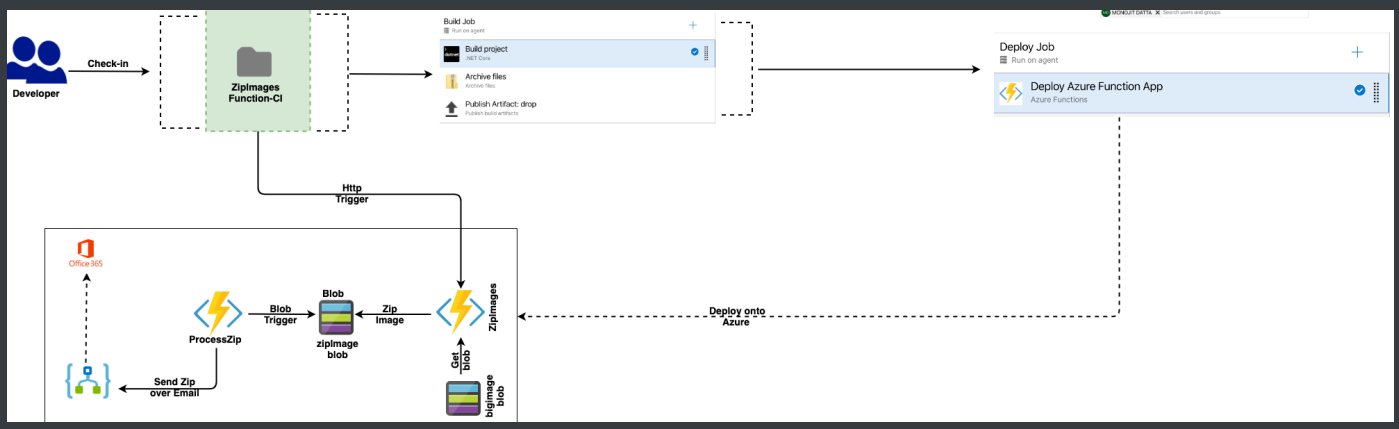

Event Hubs
Event Grid
Azure
function app
SQL Data
Warehouse
2
Capture
event
3
Capture
event
data
5
Data
migration
Storage
1
Capture
file
4
Retrieve file
SQL

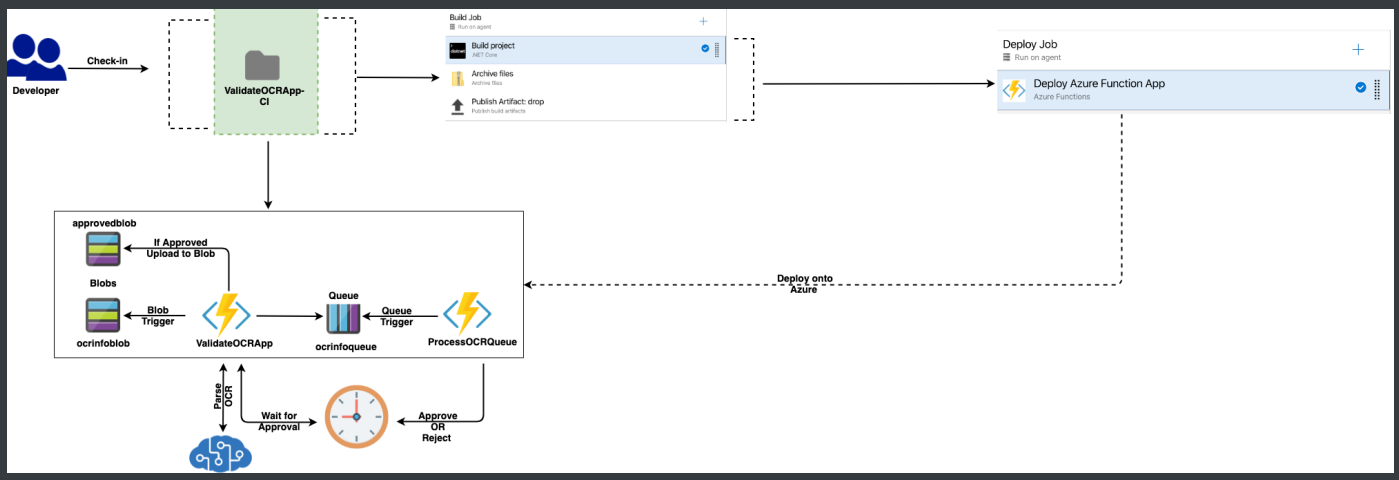


Web application backends

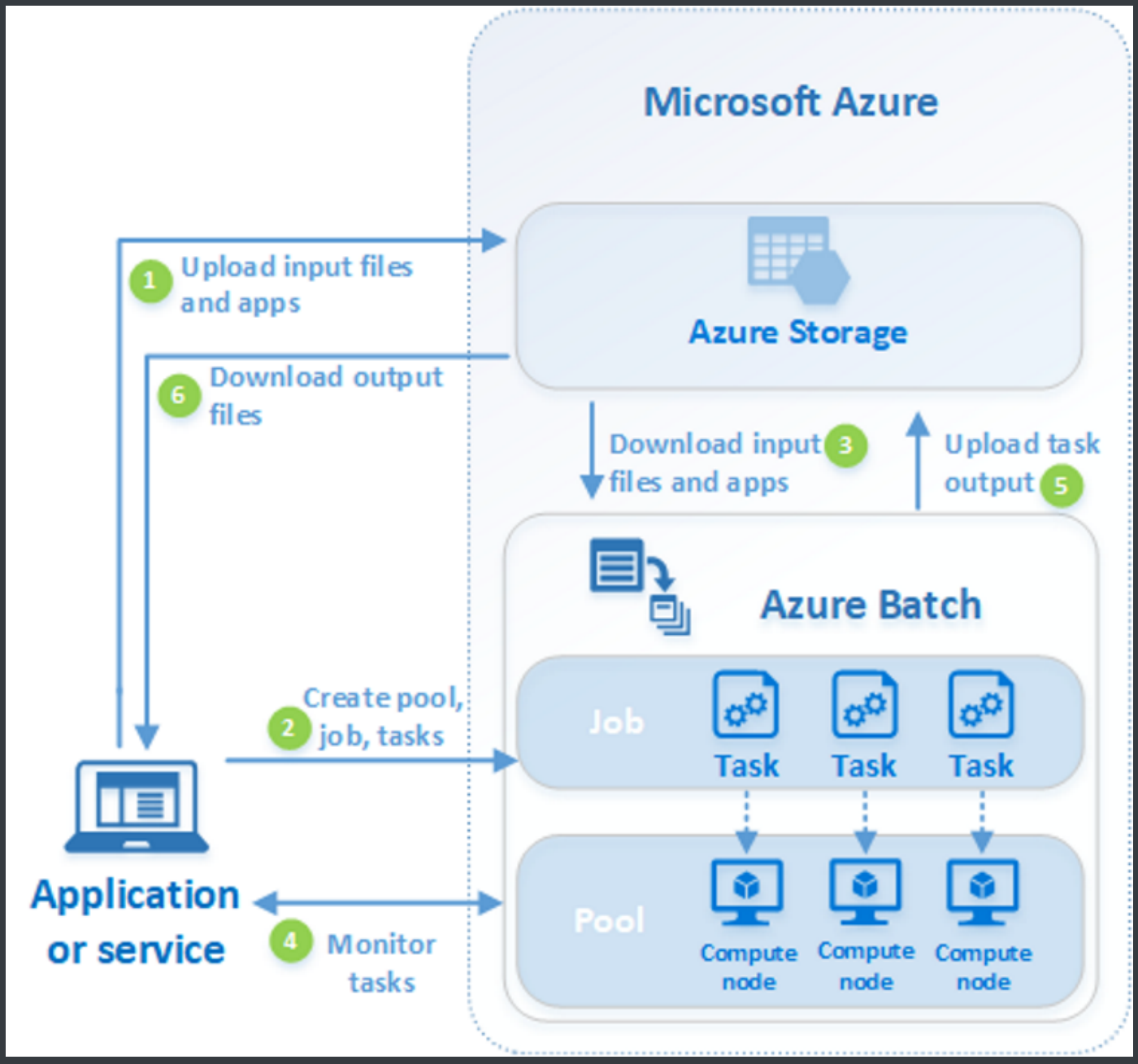
IoT-connected backends







Azure Batch



Configure Machine pool

```
private static VirtualMachineConfiguration
CreateVirtualMachineConfiguration(ImageReference imageReference)
{
    return new VirtualMachineConfiguration(
        imageReference: imageReference,
        nodeAgentSkuId: "batch.node.windows amd64");
}
```

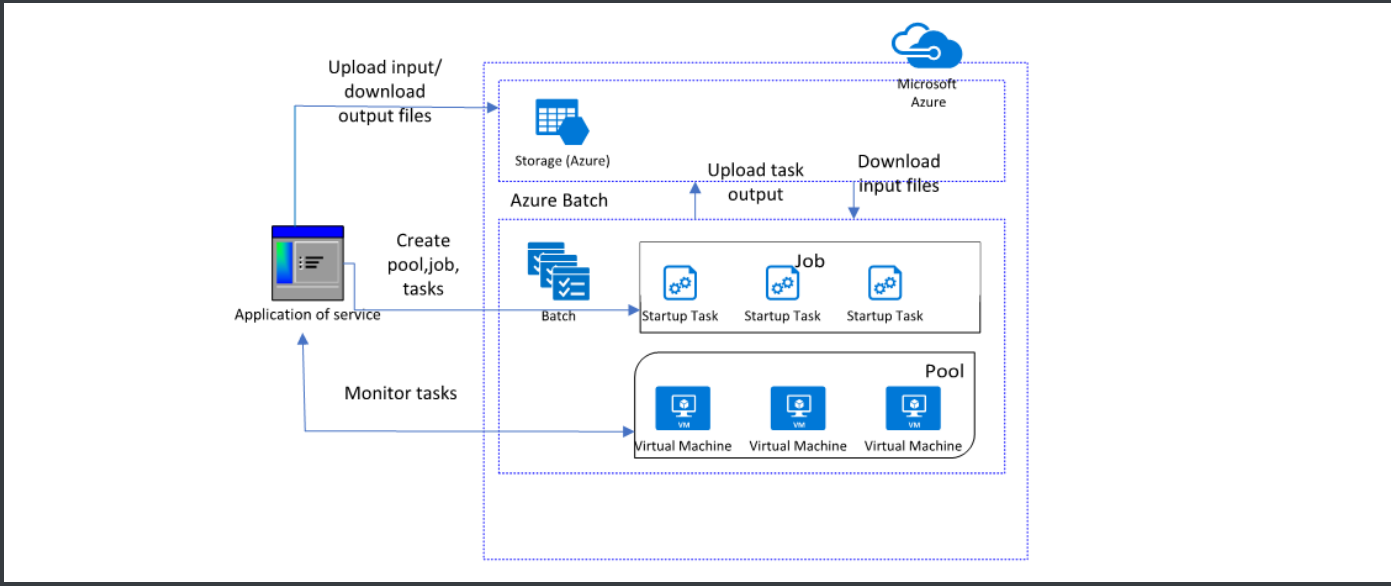
```
private static ImageReference CreateImageReference()
{
    return new ImageReference(
        publisher: "MicrosoftWindowsServer",
        offer: "WindowsServer",
        sku: "2016-datacenter-smalldisk",
        version: "latest");
}

private static void CreateBatchPool(BatchClient batchClient,
VirtualMachineConfiguration vmConfiguration)
{
    try
    {
        CloudPool pool = batchClient.PoolOperations.CreatePool(
            poolId: PoolId,
            targetDedicatedComputeNodes: PoolNodeCount,
            virtualMachineSize: PoolVMSize,
            virtualMachineConfiguration: vmConfiguration);

        pool.Commit();
    }
...
```

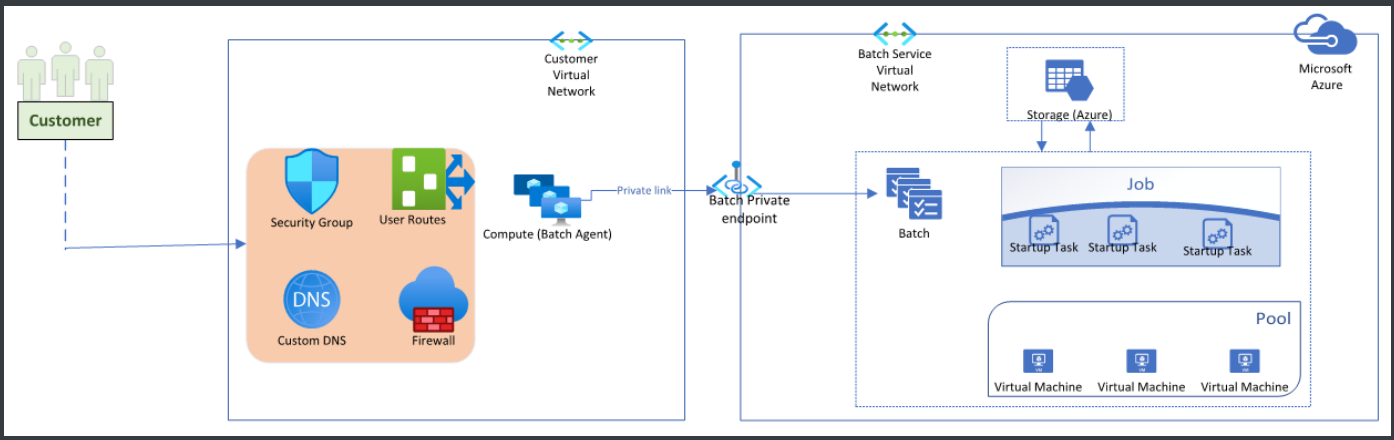
Create JOB

```
try
{
    CloudJob job = batchClient.JobOperations.CreateJob();
    job.Id = JobId;
    job.PoolInformation = new PoolInformation { PoolId = PoolId };

    job.Commit();
}
...
```

Create Tasks

```
for (int i = 0; i < inputFiles.Count; i++)
{
    string taskId = String.Format("Task{0}", i);
    string inputFilename = inputFiles[i].FilePath;
    string taskCommandLine = String.Format("cmd /c type {0}",
inputFilename);

    CloudTask task = new CloudTask(taskId, taskCommandLine);
    task.ResourceFiles = new List<ResourceFile> { inputFiles[i] };
    tasks.Add(task);
}

batchClient.JobOperations.AddTask(JobId, tasks);
```





Advanced Topics

Azure Arc

- **Event Grid Anywhere** - https://docs.microsoft.com/en-us/azure/event-grid/kubernetes/overview
- **PaaS+Serverless Anywhere** - https://docs.microsoft.com/en-us/azure/app-service/manage-create-arc-environment?tabs=bash
- **Cloud Native Anywhere** - https://codemongers.wordpress.com/2021/08/03/deploy-cloud-native-apps-anywhere-using-azure-arc-and-k8s/

References

- Event Hub - https://docs.microsoft.com/en-us/azure/event-hubs/event-hubs-about
- Event Grid - https://docs.microsoft.com/en-us/azure/event-grid/overview
- Service Bus - https://docs.microsoft.com/en-us/azure/service-bus-messaging/service-bus-messaging-overview
- Azure Batch - https://docs.microsoft.com/en-us/azure/batch/batch-technical-overview
- Durable Function - https://docs.microsoft.com/en-us/azure/azure-functions/durable/durable-functions-overview?tabs=csharp
- Logic Apps - https://docs.microsoft.com/en-us/azure/logic-apps/logic-apps-overview