Peak Hours and Double Booking Solution 1

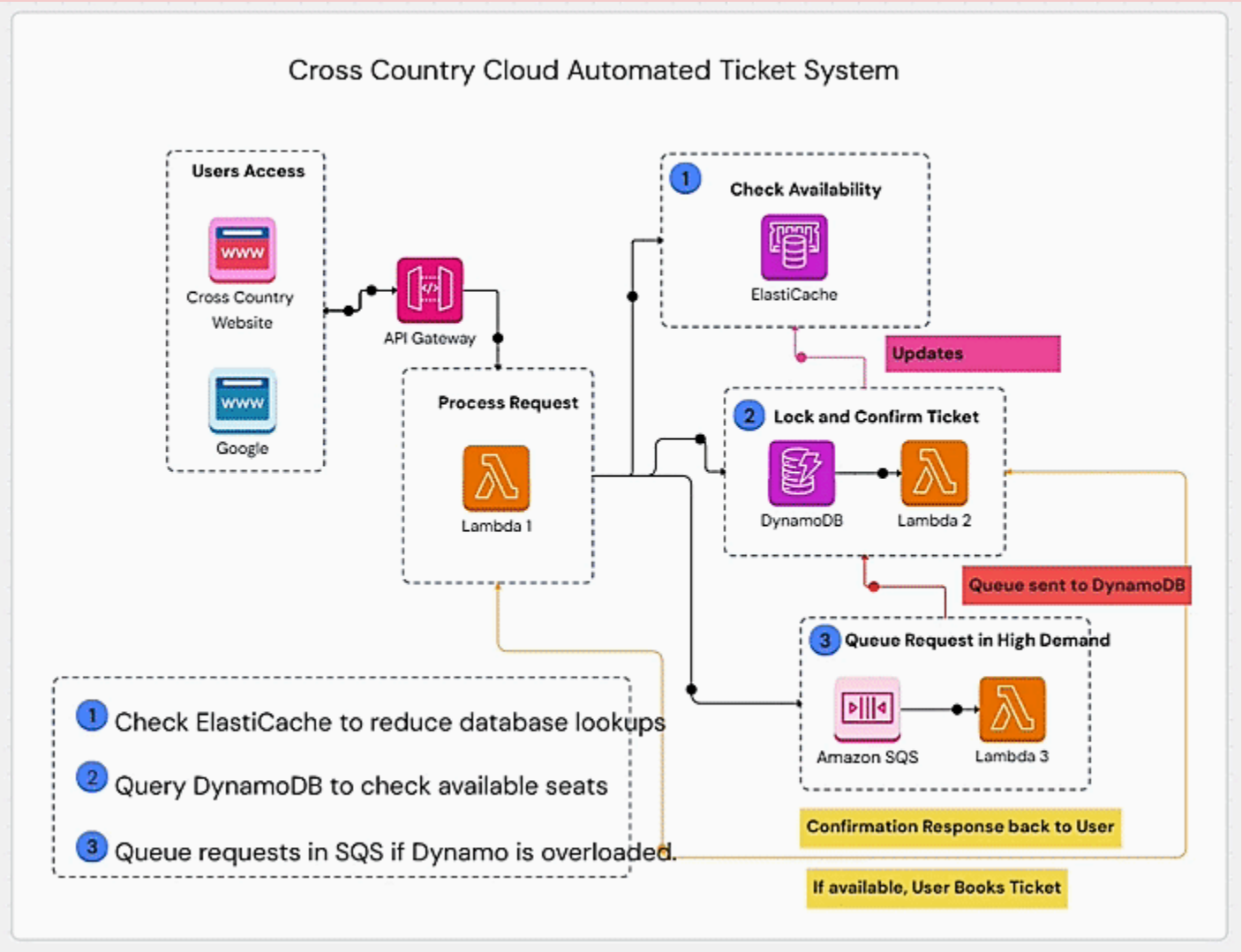
(Full Cloud Migration)

Description: Full Cloud Deployment and Migration using AWS

- **API Gateway:** Entry point for request.
- **Lambda #1:** Booking Processor.
- **DynamoDB:** Manage ticket availability and prevent double booking.
- **ElastiCache:** Caches request to alleviate requests and lower database lookups.
- **Amazon SQS:** Queues request when DynamoDB to ensure no bookings are dropped.
- **Lambda #2 and #3:** Paired with services to process requests and send and receive information.

Service	Purpose	Functions	When
API Gateway	Handles High-Traffic Requests	-Serves as the entry point for ticket booking requests. -Can handle hundreds of thousands of concurrent API calls. -Can handle 42,000+ Transactions per second. -Routes requests to AWS Lambda for processing.	Always
AWS Lambda Function #1	Cloud Autoscaling Serverless Booking Processor	-Executes when a booking request is received. -Process request from user -Check seat availability with ElastiCache and DynamoDB -Send requests to Amazon SQS if Dynamo overloaded -Confirm ticket with user if seat available	Always
Amazon ElastiCache	Speeds Up Ticket Availability Checks	-Stores cached seat availability to reduce database lookups. -Ensures real-time response times by keeping popular ticket data in memory. -DynamoDB Streams keep the cache updated with the latest bookings.	Always
Amazon DynamoDB	Manages Ticket Inventory & Prevents Double Booking	-Optimistic locking (Conditional Writes) ensures that a seat cannot be double booked. -Lock seat and confirm with user -Supports millions of transactions per second. -DynamoDB Streams syncs data with Amazon ElastiCache -Sends Confirmation to customer -Paired with **Lambda Function #2** to process request, update cache, confirm with user, optimize performance, and auto scale to meet demand	When ElastiCache not updated
Amazon SQS	Queues High-Traffic Requests During Peaks	-Ensures no request is dropped when traffic spikes. -If DynamoDB is overwhelmed, Lambda places booking requests into an SQS queue. -Sends Requests to DynamoDB when available -Paired with **Lambda Function #3** to process queued requests, optimize performance, and auto scale to meet demand	High Demand if DynamoDB is overwhelmed

Diagram


Cross Country Cloud Automated Ticket System
Users Access
Cross Country Website
Google
API Gateway
Process Request
Lambda 1
1
Check Availability
ElastiCache
Updates
2
Lock and Confirm Ticket
DynamoDB
Lambda 2
Queue sent to DynamoDB
3
Queue Request in High Demand
Amazon SQS
Lambda 3
Confirmation Response back to User
If available, User Books Ticket
1 Check ElastiCache to reduce database lookups
2 Query DynamoDB to check available seats
3 Queue requests in SQS if Dynamo is overloaded.

Peak Hours and Double Booking Solution 2

(Cloud Bursting “Hybrid”)

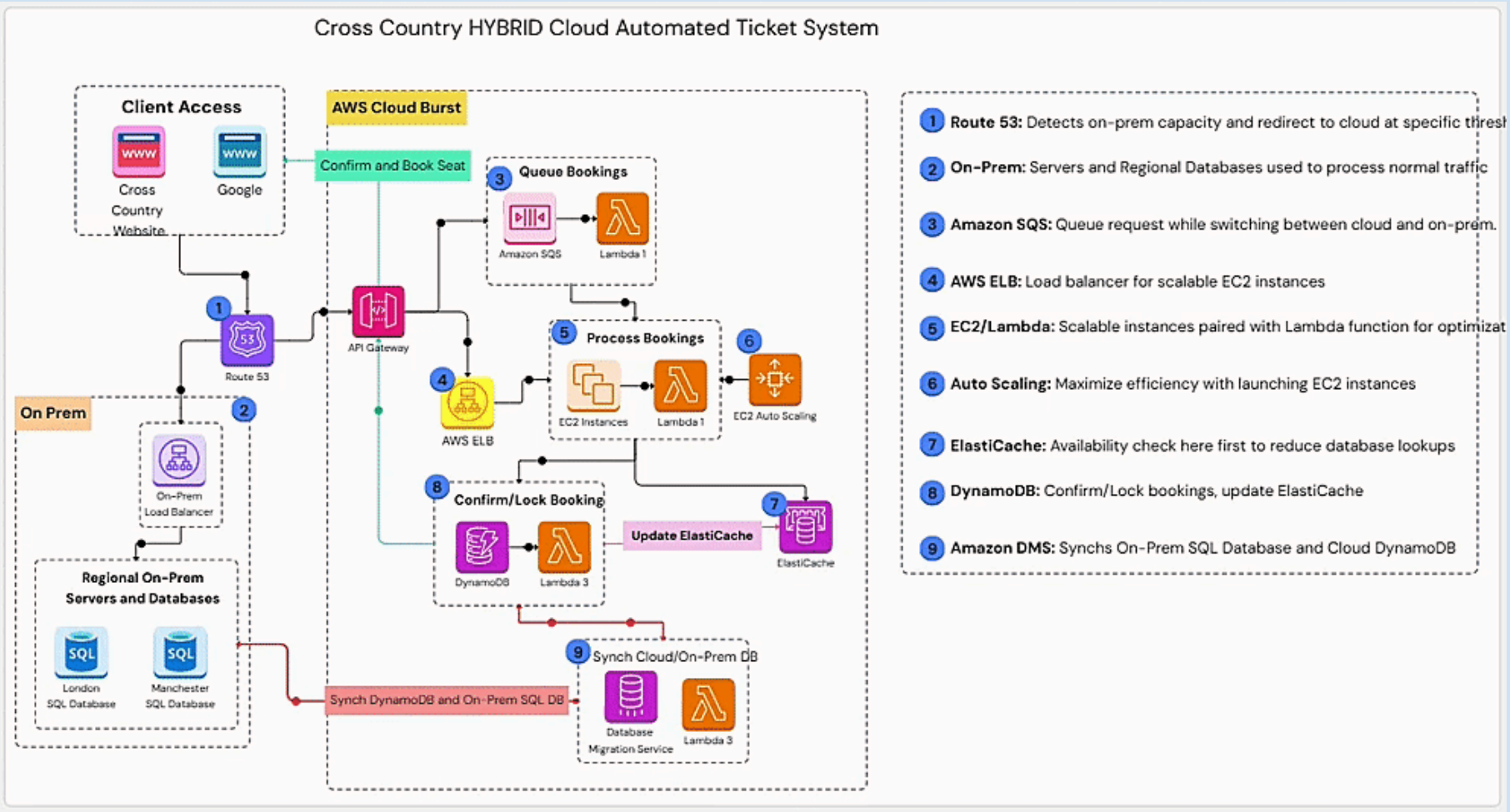
How it works:

Normal Load: Route 53 prioritizes on-prem resources first. On prem Databases are used to process requests
Peak Load: When capacity is reached, Route 53 directs traffic to Cloud Resources.
**Minimal cloud resources can be used concurrently with on-prem to minimize cloud costs and utilize on-prem resources at all times.

Service	Purpose	Functions	When it is used
AWS Route 53	Scalable Domain Name Service	-Route service between On-Prem and AWS cloud resources -Detects On-Prem server at capacity and redirects to AWS ELB -Gradually shift back to on-prem when resources available	Always
On-Prem Load Balancer	Balance traffic across on-prem servers	-Receive Traffic -Monitor on-prem resource usage and request rate -Marks servers as overloaded -Balance requests between servers -Detects Overload -Example: CPU > 85% or 5,000 TPS -Update Route 53 to redirect traffic to AWS	Normal Demand
On-Prem Servers and Data Center	SQL Databases and Servers (London and Manchester)	-Process Ticket Sells at normal traffic levels -Track Available Seats -Store Data -Return Booking Confirmation to user	Normal Demand
Cloud Burst during high Demand			
API Gateway	Handles High-Traffic Requests	-Serves as the entry point for ticket booking requests in the cloud. -Can handle hundreds of thousands of concurrent API calls. -Can handle 42,000+ Transactions per second. -Routes requests to AWS ELB.	High Demand
Amazon SQS + Lambda	Queues Requests	-Queues requests when traffic switches between on-prem and cloud -Lambda function picks up and processes queued requests without blocking users.	While switching between on-prem and cloud
AWS Elastic Load Balancer	Balance traffic across AWS	-Distribute requests evenly across healthy EC2 instances -Prevent overload on any single server	High Demand

	servers	-Primary trafficker if on-prem fails -Works together with AWS Auto Scaling to maximize performance and cost	
AWS Auto Scaling	Adjust number of EC2 instances	-Launches with AWS ELB during high demand -Works together with AWS ELB to maximize performance and cost -Ensures there are enough EC2 instances to handle traffic -Dynamically increases and decreases EC2 instances based on demand	High Demand
EC2 Instances	Scalable On-Demand Backup Servers	-Primary cloud compute resource to handle application logic and requests -Handle overflow traffic when on-prem resources are overloaded -Check ElastiCache for seat availability -Query DynamoDB (if ElastiCache not updated) -Increase and decrease (scale) based on Demand	High Demand
EC2 Lambda Functions	Offload compute Functions	-Improve efficiency -Process queued request -Enhance EC2 functionality -Handle background tasks -Optimize database lookups -real-time updates	High Demand
Amazon DynamoDB + Lambda	Manages Ticket Inventory & Prevents Double Booking	-Optimistic locking (Conditional Writes) ensures that a seat cannot be double-booked. -Lock seat and confirm with user -Supports millions of transactions per second. -DynamoDB **Streams** syncs data with Amazon ElastiCache for fast availability checks. -Sends Confirmation to customer -Process queued requests from Amazon SQS -Amazon DMS synchs On-Prem DB with DynamoDB	High Demand
Amazon ElastiCache + Lambda	Speeds Up Ticket Availability Checks	-Stores cached seat availability to reduce database lookups. -Ensures real-time response times by keeping popular ticket data in memory. -DynamoDB Streams keep the cache updated with the latest bookings. -If cache is not updated, DynamoDB is accessed	`High Demand
AWS Database Migration Service (DMS)	Synchronize data between On-Prem and Cloud	-Continuous synchronization so On-Prem and Cloud data match -Crucial for avoiding double booking while switching to and from on-prem and cloud	Normal and High Demand

Diagram:


Cross Country HYBRID Cloud Automated Ticket System
Client Access
Cross Country Website
Google
AWS Cloud Burst
Confirm and Book Seat
3 Queue Bookings
Amazon SQS
Lambda 1
1
Route 53
API Gateway
4
AWS ELB
5 Process Bookings
EC2 Instances
Lambda 1
6
EC2 Auto Scaling
On Prem
2
On-Prem Load Balancer
Regional On-Prem Servers and Databases
London SQL Database
Manchester SQL Database
8 Confirm/Lock Booking
DynamoDB
Lambda 3
Update ElastiCache
7
ElastiCache
9 Synch Cloud/On-Prem DB
Synch DynamoDB and On-Prem SQL DB
Database Migration Service
Lambda 3
1 Route 53: Detects on-prem capacity and redirect to cloud at specific thresl
2 On-Prem: Servers and Regional Databases used to process normal traffic
3 Amazon SQS: Queue request while switching between cloud and on-prem.
4 AWS ELB: Load balancer for scalable EC2 instances
5 EC2/Lambda: Scalable instances paired with Lambda function for optimizat
6 Auto Scaling: Maximize efficiency with launching EC2 instances
7 ElastiCache: Availability check here first to reduce database lookups
8 DynamoDB: Confirm/Lock bookings, update ElastiCache
9 Amazon DMS: Synchs On-Prem SQL Database and Cloud DynamoDB

Cost Comparison

I attempted to use the AWS Pricing Calculator but there are too many unknowns to do a full cost analysis. Such as data storage size, average item size, write and rewrite settings, etc. So instead, I am going to do a general cost analysis and make an estimate based on average industry cost. This will be a rough estimate.

Category	On-Prem Cost	Hybrid Cost	Full Cloud Cost
Infrastructure & Hardware Costs	High (Buying & upgrading servers)	Medium (On-prem + cloud integration)	Low (AWS owns infrastructure)
Operational & Maintenance Costs	High (IT staff, power, cooling)	Medium (Some IT staff still needed)	Low (AWS manages infrastructure)
Operational & Maintenance Costs	High (IT staff, power, cooling)	Medium (Some IT staff still needed)	Low (AWS manages infrastructure)
Scalability & Flexibility Costs	High (Requires new hardware purchases)	Medium (Cloud scales, on-prem does not)	Low (Auto Scaling & pay-as-you-go)
Software Licensing & Database Costs	High (SQL Server, VMware, etc.)	Medium (Some software moves to cloud)	Low (AWS RDS, DynamoDB reduce licensing needs)
Network & Connectivity Costs	High (Data center bandwidth, VPN)	Medium (AWS Direct Connect/VPN fees)	Low (AWS handles global networking)
Storage Costs	High (SAN/NAS storage purchase)	Medium (AWS S3 + on-prem storage)	Low (AWS S3, EBS, Glacier)
Security & Compliance Costs	High (Firewalls, compliance audits)	Medium (Some AWS security tools used)	Low (AWS handles compliance & security)
Disaster Recovery & High Availability Costs	High (Multiple data centers required)	Medium (AWS provides failover)	Low (AWS offers global failover options)
IT Staffing Costs	High (24/7 on-site engineers)	Medium (Some engineers needed)	Low (AWS handles maintenance)
Electricity & Facility Costs	High (Power, cooling, real estate)	Medium (Smaller on-prem footprint)	Low (AWS data centers are optimized)
Total Cost of Ownership (TCO)	High	Medium	Low

Category Breakdown				
1. Infrastructure & Hardware Costs **On-Prem:** Organizations must buy and replace physical servers, storage, networking gear every 3-5 years. **Hybrid Cloud:** Reduces some infrastructure costs, but on-prem hardware is still required. **Full Cloud:** No upfront hardware purchases—AWS manages infrastructure. **Cloud is more cost-effective for businesses that need to scale quickly.**	**2. Operational & Maintenance Costs** **On-Prem:** IT teams must manage, update, and troubleshoot physical hardware 24/7. **Hybrid Cloud:** Some maintenance is offloaded to AWS, but on-prem systems still require management. **Full Cloud:** AWS handles maintenance, patching, and monitoring at no extra cost. **Cloud eliminates hardware maintenance and IT overhead.**	**3. Scalability & Flexibility Costs** **On-Prem:** Scaling requires buying more servers and waiting weeks/months for delivery. **Hybrid Cloud:** AWS provides on-demand Auto Scaling, but on-prem systems remain fixed. **Full Cloud:** Auto Scaling instantly adds or removes resources, reducing cost waste. **AWS Auto Scaling ensures businesses only pay for what they use.**	**4. Software Licensing & Database Costs** **On-Prem:** SQL Server, Windows Server, VMware, and other licenses must be purchased. **Hybrid Cloud:** Some workloads can migrate to AWS RDS (managed SQL/PostgreSQL), reducing licensing needs. **Full Cloud:** AWS provides DynamoDB, Aurora, RDS with built-in licensing, reducing costs. **Cloud reduces software licensing costs by offering managed services.**	**5. Network & Connectivity Costs** **On-Prem:** High networking costs (bandwidth, VPNs, data center connectivity). **Hybrid Cloud:** AWS Direct Connect or VPNs are required to link on-prem to AWS. **Full Cloud:** Cloud-native networking (AWS VPC, Transit Gateway) is fully managed. **Cloud networking is cheaper for global deployments.**
6. Storage Costs **On-Prem:** Expensive SAN/NAS storage upgrades every few years. **Hybrid Cloud:** Some data remains on-prem, but AWS S3 & EBS reduce costs. **Full Cloud:** AWS S3, EBS, and Glacier provide cost-effective, scalable storage. **AWS storage eliminates upfront hardware costs and scales automatically.**	**7. Security & Compliance Costs** **On-Prem:** Businesses must pay for firewalls, intrusion detection, compliance audits. **Hybrid Cloud:** AWS security tools (IAM, AWS Shield, GuardDuty) reduce risks. **Full Cloud**: AWS handles security, compliance certifications, and audits. **AWS reduces compliance and security costs significantly.**	**8. Disaster Recovery & High Availability** **On-Prem:** Requires secondary data centers for failover, increasing costs. **Hybrid Cloud:** AWS can provide DR solutions (multi-region backups, failover). **Full Cloud:** AWS offers automated backups, global failover, and disaster recovery (AWS Backup, Route 53 Failover). **Cloud reduces disaster recovery costs by providing built-in failover solutions.**	**9. IT Staffing Costs** **On-Prem:** Requires 24/7 engineers, security, and networking teams. **Hybrid Cloud:** AWS reduces staffing needs, but some on-prem IT staff is still required. **Full Cloud:** AWS handles most infrastructure maintenance, reducing IT staff costs. **Cloud enables businesses to operate with fewer in-house IT staff.**	**10. Electricity & Facility Costs** **On-Prem:** High power and cooling costs for data centers. **Hybrid Cloud:** On-prem footprint is reduced, lowering electricity bills. **Full Cloud:** No power costs—AWS optimizes energy efficiency. **Cloud eliminates data center electricity costs.**

Cost Comparison Across			
Cost Category	**On-Prem**	**Hybrid Cloud**	**Full Cloud**
Hardware & Refresh (Every 5 Years)	$7,500,000	$2,500,000	$0
Software Licensing	$150,000	$75,000	$0
IT Staffing (24/7 Support, Engineers)	$350,000	$200,000	$100,000
Power, Cooling, and Real Estate	$1,962,360	$981,180	$0
AWS Compute (EC2, Lambda, Auto Scaling)	$0	$24,000	$300,000
AWS Storage (S3, EBS, Glacier, DynamoDB)	$0	$75,000	$150,000
AWS Networking (Route 53, Direct Connect, Transit Gateway)	$0	$50,000	$100,000
Security & Compliance	$75,000	$30,000	$20,000
Disaster Recovery & Backup	$100,000	$50,000	$25,000
API Gateway Costs (Monthly)	$60,000	$210	$420
***Total Annual Cost**	*$2,697,360	*$1,485,230	$995,420
***Total 5-Year Cost (Including Hardware Refresh)**	*$20,986,800	*$9,926,150	$4,977,600
***Note:** Annual costs do not include hardware and refresh but 5 year costs do include maintenance and refresh.			
AWS Cost Estimate			
I used AWS Price Calculator to estimate a few costs directly in cases where I had enough information. Google Drive Link			

Compare and Contrast Solutions

Pros and Cons

Hybrid Cloud (On-Prem + AWS Cloud)

Uses existing on-prem infrastructure while scaling to AWS for peak demand.

✅ Pros of Hybrid Cloud

✔ **Leverages Existing Investments** – Uses already owned data centers (London & Manchester), reducing cloud costs.
✔ **Regulatory Compliance** – Some industries require local data storage, which can be handled on-prem.
✔ **Latency Optimization** – Keeps critical workloads close to users in specific regions (e.g., UK customers get local response times).
✔ **Gradual Cloud Transition** – Allows a step-by-step migration to AWS without full commitment.
✔ **Failover & Redundancy** – If on-prem goes down, AWS provides high availability.

❌ Cons of Hybrid Cloud

✖ **Complexity & Management Overhead** – Requires managing both on-prem and cloud resources, increasing operational workload.
✖ **Higher Infrastructure Costs** – Need to maintain on-prem hardware, staffing, and maintenance costs alongside cloud expenses.
✖ **Latency Between On-Prem & Cloud** – Data synchronization between on-prem and AWS introduces potential latency.
✖ **Security & Compliance Risks** – Data consistency and security policies need to be enforced across both environments.

Full Cloud Solution (AWS-Only)

Moves everything to AWS, eliminating on-premises infrastructure.

✅ Pros of Full Cloud

✔ **Scalability** – AWS Auto Scaling handles traffic spikes instantly with no physical hardware limits.
✔ **Cost Efficiency** – No upfront investment in hardware; pay only for what is used.
✔ **Simplified Management** – AWS manages hardware, networking, redundancy, and disaster recovery automatically.
✔ **High Availability & Disaster Recovery** – Multi-AZ and Multi-Region deployment ensure near 100% uptime.
✔ **Better Performance** – Global AWS infrastructure ensures low latency worldwide without physical limitations.

❌ Cons of Full Cloud

✖ **Migration Costs & Effort** – A full shift to the cloud requires refactoring legacy applications and may involve downtime.
✖ **Vendor Lock-in** – Fully relying on AWS means potential cost increases over time with limited exit strategies.
✖ **Data Transfer Costs** – Moving large amounts of data to/from AWS can be expensive (AWS egress charges).
✖ **Latency for On-Prem Dependent Systems** – If some workloads still rely on on-prem services, network delays might occur.

Cloud Servers

Hybrid: **EC2 Instances**

Hybrid Cloud Uses Auto Scaling EC2 Because It Mimics On-Prem Servers

Full Cloud: **Serverless**

Full Cloud Uses AWS Lambda Because It's Fully Serverless

- When fully in AWS, there's no need for traditional servers (EC2), so everything can be event-driven and serverless.

- Hybrid Cloud is designed to extend on-premise infrastructure, so AWS needs to work similarly to on-prem servers.
- EC2 instances allow the same software and applications that run on-prem to run in AWS without modification.
- Many legacy applications (monolithic apps) are not serverless-compatible, so EC2 provides a direct lift-and-shift option. Auto Scaling ensures AWS can handle peak load dynamically while still working with on-prem components.

- AWS Lambda scales automatically and handles high volumes (42,000+ transactions per second) without infrastructure management.
- No need to maintain or configure servers, reducing costs and complexity.
- Ideal for microservices-based applications where each function runs independently.

Factor	Hybrid (Auto Scaling EC2)	Full Cloud (AWS Lambda)
Compute Model	Uses EC2 instances (traditional servers)	Uses AWS Lambda (serverless functions)
Scaling	Auto Scaling launches **more EC2 instances** as needed	Lambda scales **automatically, no servers needed**
Cost Efficiency	Pay for running EC2 instances, even when idle	Pay **only for actual function execution**
Compatibility	Best for applications that require **traditional infrastructure**	Best for **fully cloud-native** applications
Management Overhead	Requires managing EC2 instances, OS updates, security patches	AWS fully manages Lambda, no OS maintenance
Startup Time	Slower (EC2 needs to boot up new instances)	Faster (Lambda executes instantly)
Use Case	Extends on-prem systems to AWS without major changes	Built for cloud-first, event-driven architectures

Final Recommendations

Hybrid Cloud is best if:

- You must keep some workloads on-prem (e.g., compliance, local storage).
- You already invested heavily in on-prem data centers and want to extend capacity with AWS.
- You need a gradual transition to the cloud.

Full Cloud (AWS-Only) is best if:

- You want full scalability, automation, and reduced maintenance costs.
- You are ready to migrate everything to AWS without on-prem dependencies.
- Your goal is high availability, performance, and cost savings long-term.