EOSDIS
NASA'S EARTH OBSERVING SYSTEM
DATA AND INFORMATION SYSTEM

Lessons Learned while Exploring Cloud-Native Architectures for NASA EOSDIS Applications and Systems

Dan Pilone (dan@element84.com)
Brett McLaughlin (brett@element84.com)
Peter Plofchan (Peter.G.Plofchan@raytheon.com)

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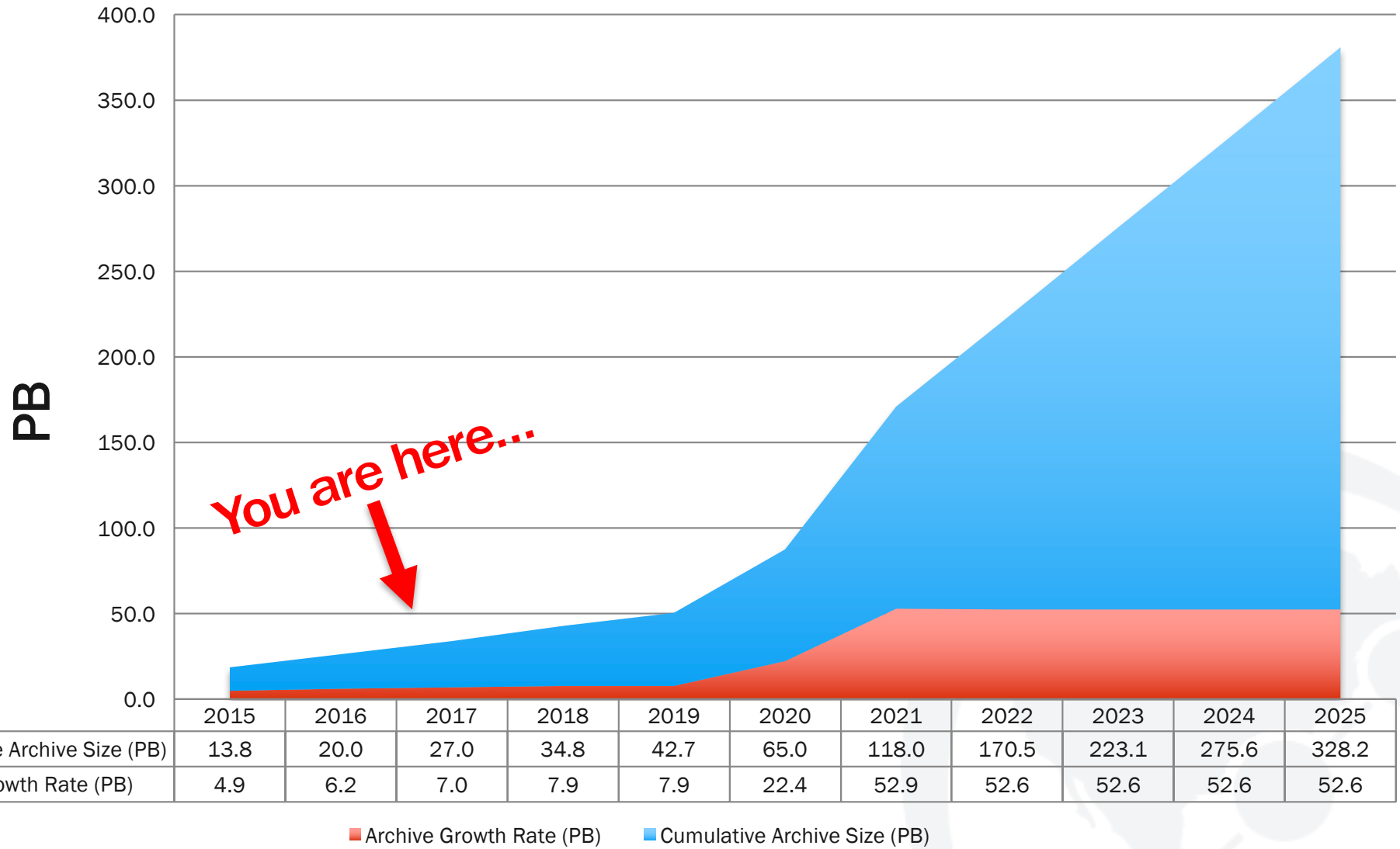
Formulation
Implementation
Primary Ops
Extended Ops
Sentinel-6A/B
Earth Science Instruments on ISS:
RapidScat, CATS,
LIS, SAGE III (on ISS), TSIS-1, OCO-3, ECOSTRESS,
GEDI, CLARREO-PF
Landsat 9
PACE
NI-SAR
SWOT
TEMPO
JPSS-2 (NOAA)
RBI, OMPS-Limb
GRACE-FO (2)
ICESat-2
CYGNSS
ISS
SORCE,
TCTE (NOAA)
NISTAR, EPIC
(NOAA'S DSCOVR)
QuikSCAT
EO-1
Landsat 7
(USGS)
SMAP
Terra
Suomi NPP (NOAA)
Aqua
CloudSat
Landsat 8
(USGS)
CALIPSO
Aura
GPM
GRACE (2)
OSTM/Jason 2
(NOAA)
OCO-2

EOSDIS Archive Growth *Estimate* (Prime + Extended)



	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Cumulative Archive Size (PB)	13.8	20.0	27.0	34.8	42.7	65.0	118.0	170.5	223.1	275.6	328.2
Archive Growth Rate (PB)	4.9	6.2	7.0	7.9	7.9	22.4	52.9	52.6	52.6	52.6	52.6

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Lots of assumptions in this chart. Subject to change...

ExCEL Efforts and Project Prototypes

NGAP

NASA Compliant General Application Platform (NGAP), an operational, dev-ops, and sandbox AWS cloud based operating environment.

ASF WOS Prototype

AWS/NGAP Web Object Storage (WSO) prototyping large volumes of mission data dynamically between AWS S3, S3-IA, and Glacier object storage. Managed out of Alaska Satellite Facility

Earthdata Search Client to Cloud

NASA Earth Science data search by keyword and advanced filters such as time and space

Cumulus

Prototype addressing core EOSDIS capabilities including data ingest, archive, management, and distribution of large volumes of EOS data.

Getting Ready for NISAR (GRFN)

Integrated prototype of science product generation and delivery from a DAAC system focused on coupling ASF DAAC and JPL ARIA systems.

CATEES

Easy-to-use Python tools packaged to support EOSDIS cross-DAAC science workflows and analytics over large volumes of EOS data in AWS.

ECC to Cloud Study

Earth Code Collaborative (ECC) study to determine cloud ready capabilities to migrate into AWS/NGAP platform.

ExCEL Efforts and Project Prototypes Continued

GIBS in the Cloud

Migrating GIBS to the AWS/NGAP Cloud based on recommendations made in the "GIBS in the Cloud Study"

Earthdata Login to Cloud Study

Study to determine and recommend migrating the Earthdata Login into AWS/NGAP cloud environment

CMR to Cloud

Migration of the Common Metadata Repository, into the AWS/NGAP platform based on recommendations made in the CMR to Cloud study.

OPeNDAP/HDF Cloud Studies

Study to determine and recommend a cloud native integration of OPeNDAP accessing HDF5 and netCDF4 data on AWS/NGAP platform.

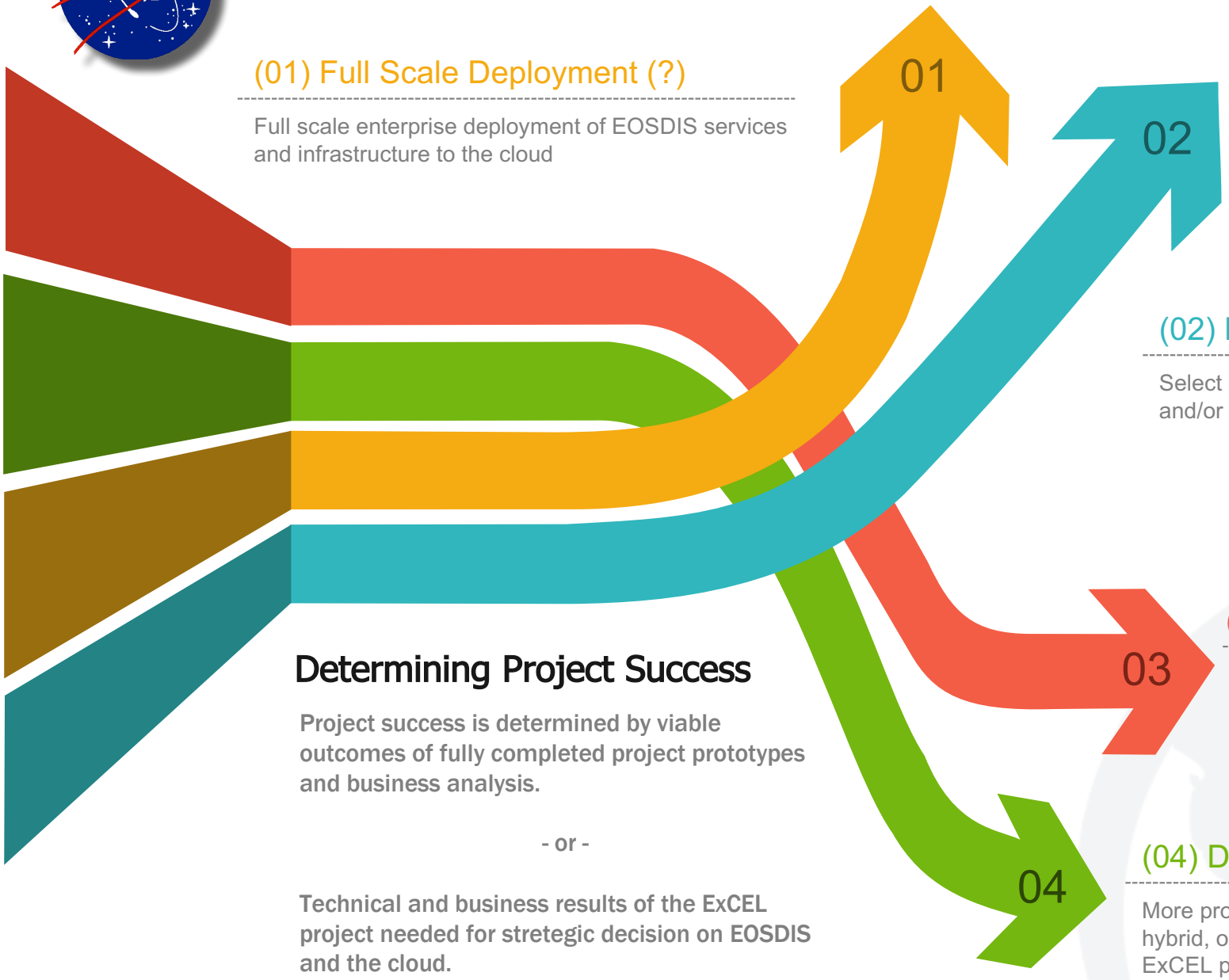
NEXUS

Prototype to accelerate end-user analysis of remote sensing data, highly parallel to better enable science discovery

Network Prototypes

Network prototypes to support to test security, monitoring, logging, and to perform R&D testing to support all ExCEL project prototypes.

ExCEL Go/No-Go



(01) Full Scale Deployment (?)

Full scale enterprise deployment of EOSDIS services and infrastructure to the cloud

(02) Partial Deployment (?)

Select deployment of EOSDIS services and/or infrastructure to the cloud

(03) Cloud Stand-down (?)

No EOSDIS services or infrastructure operationally migrated to the cloud

(04) Decision Point (?)

More prototyping required, or cloud hybrid, or other next steps based on ExCEL prototyping and business analysis results

Determining Project Success

Project success is determined by viable outcomes of fully completed project prototypes and business analysis.

- or -

Technical and business results of the ExCEL project needed for stretegic decision on EOSDIS and the cloud.

Lessons Learned

- Technical
- Psycho-Social
- Cost

Technical Lesson 1

ENABLE CLOUD NATIVE ARCHITECTURES BY STRONGLY PREFERRING CLOUD SERVICES

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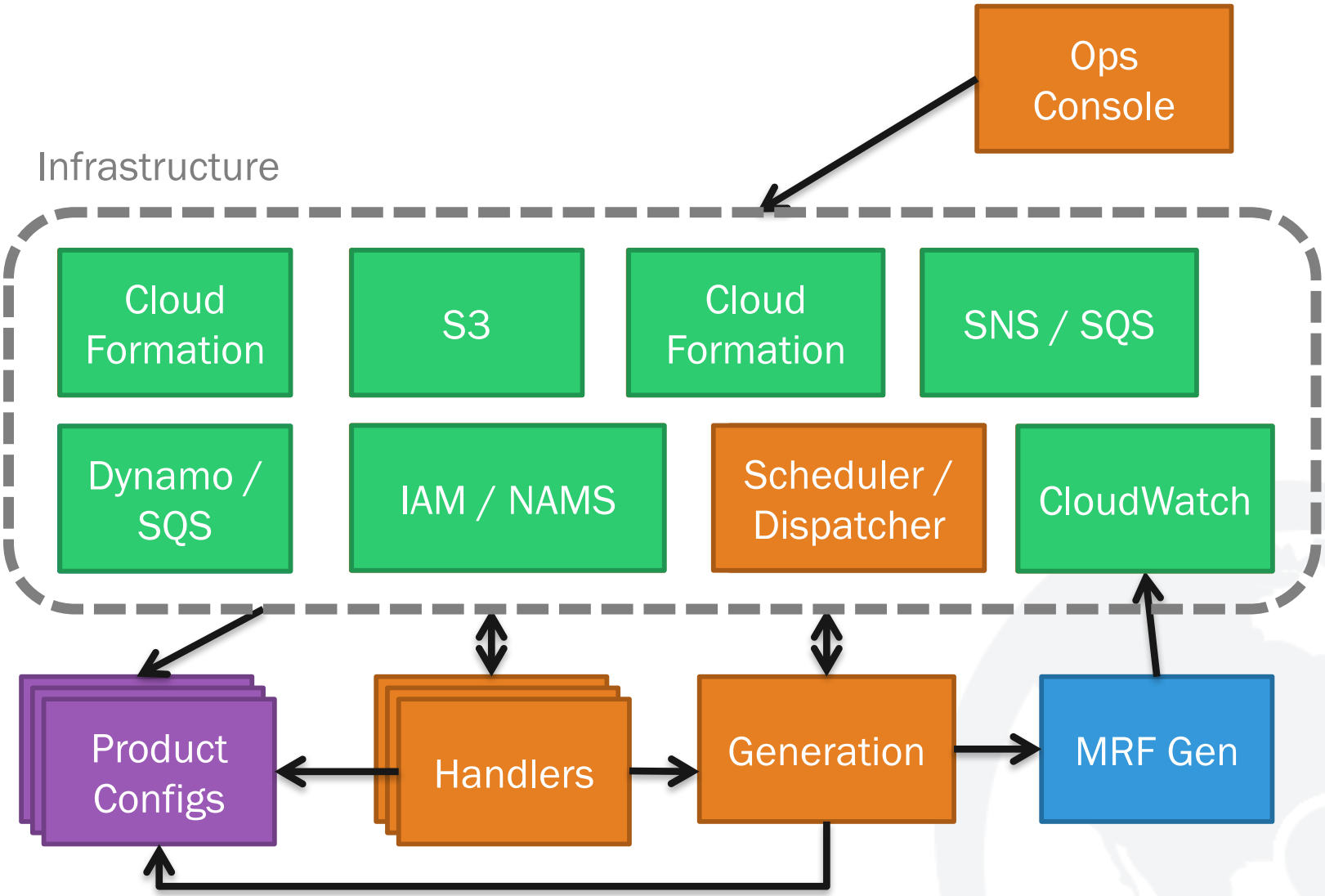
GIBS-in-the-Cloud Service Swap



Custom Software
Cloud Services
External NASA/GIBS Library
Data

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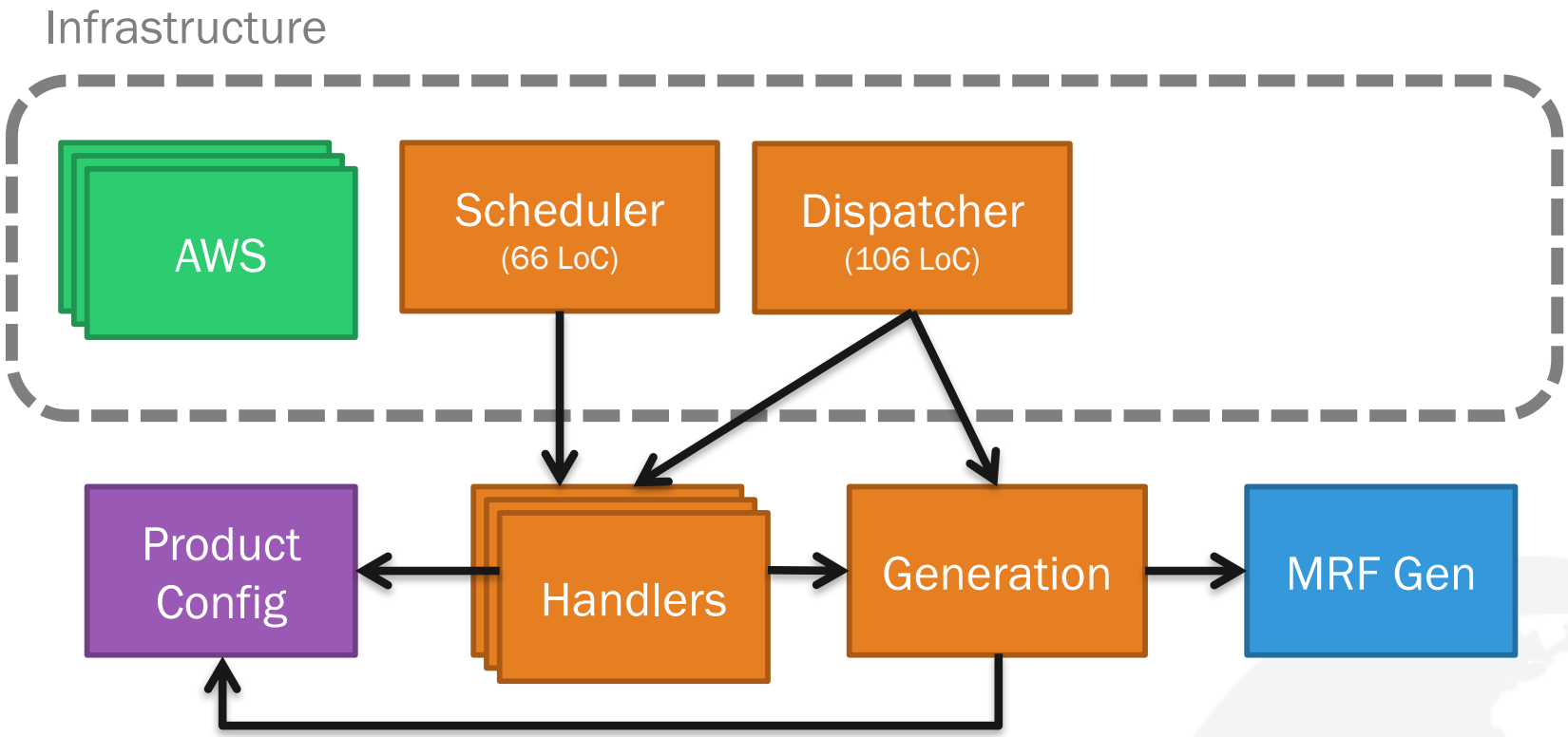
GIBS-in-the-Cloud Ingest and Processing



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The Big 4

1. EC2 Instances
   - More instances *running* = more cost
2. EBS Storage
   - More EBS* = more cost
3. Data Transfer
   - Notably: egress, egress, and egress
4. S3 Storage
   - More storage = more cost

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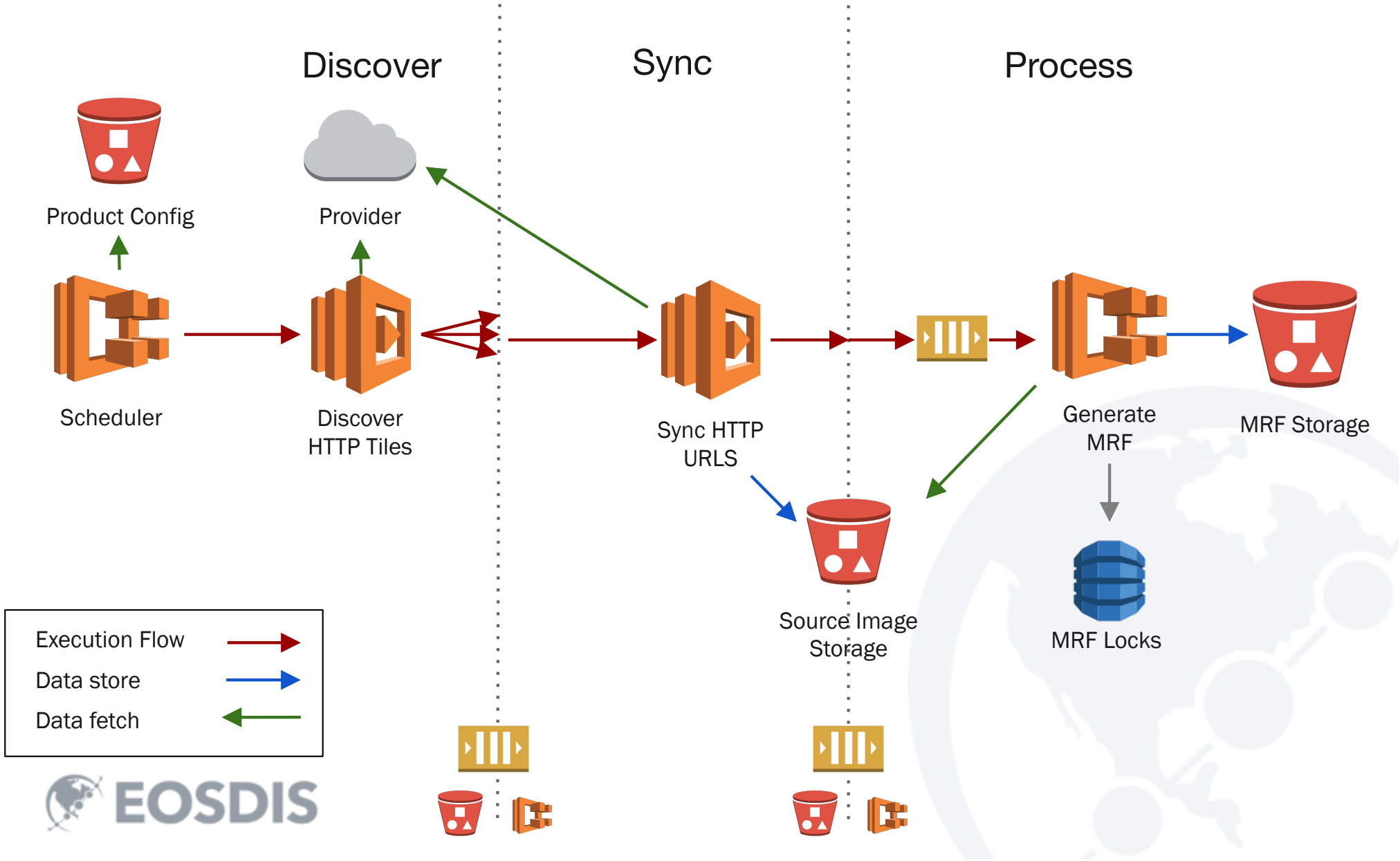
** EBS storage has costs associated even when not in use by a running EC2 instance*

Ingest: MODAPS Tiles



The Big 4… but server-less

1. ~~EC2 Instances~~
   - Zero to heavily reduced instances
2. ~~EBS Storage~~
   - Less EC2 generally means less EBS
3. Data Transfer
   - Notably: egress, egress, and egress
4. S3 Storage
   - More storage = more cost

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** EBS storage has costs associated even when not in use by a running EC2 instance*

Technical Lesson 2

AWS HAS VERY LOW INTERNAL LATENCY – BUT TRUST NOTHING.

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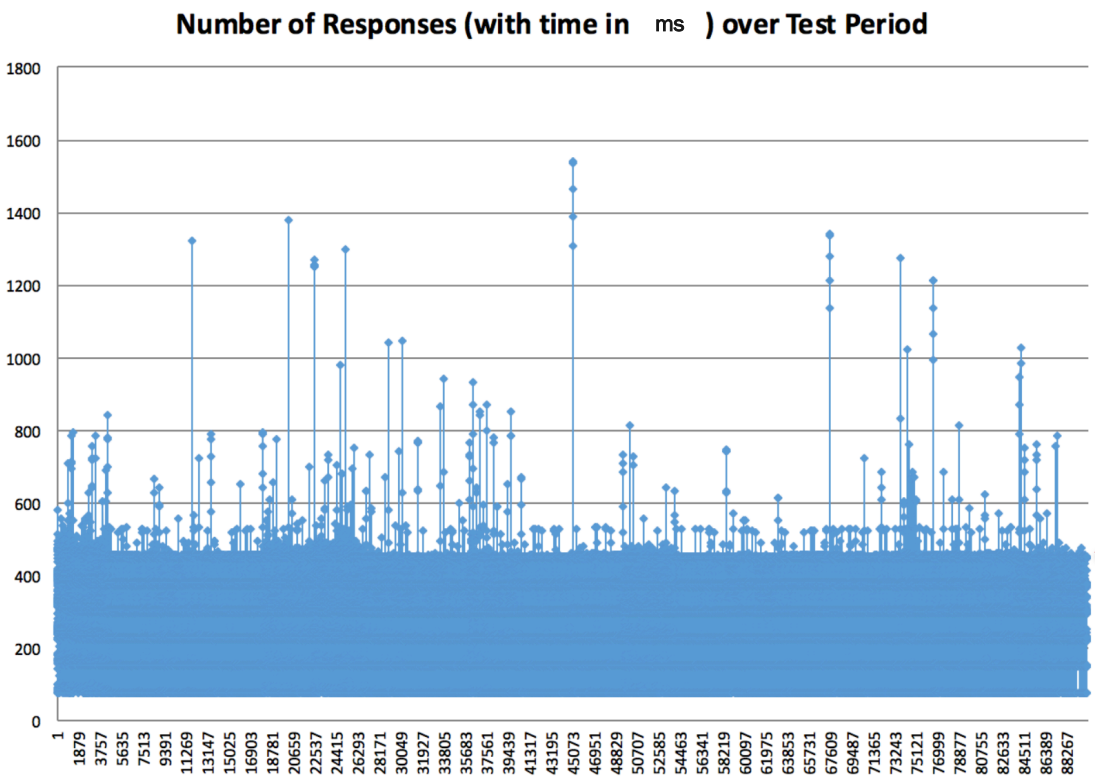
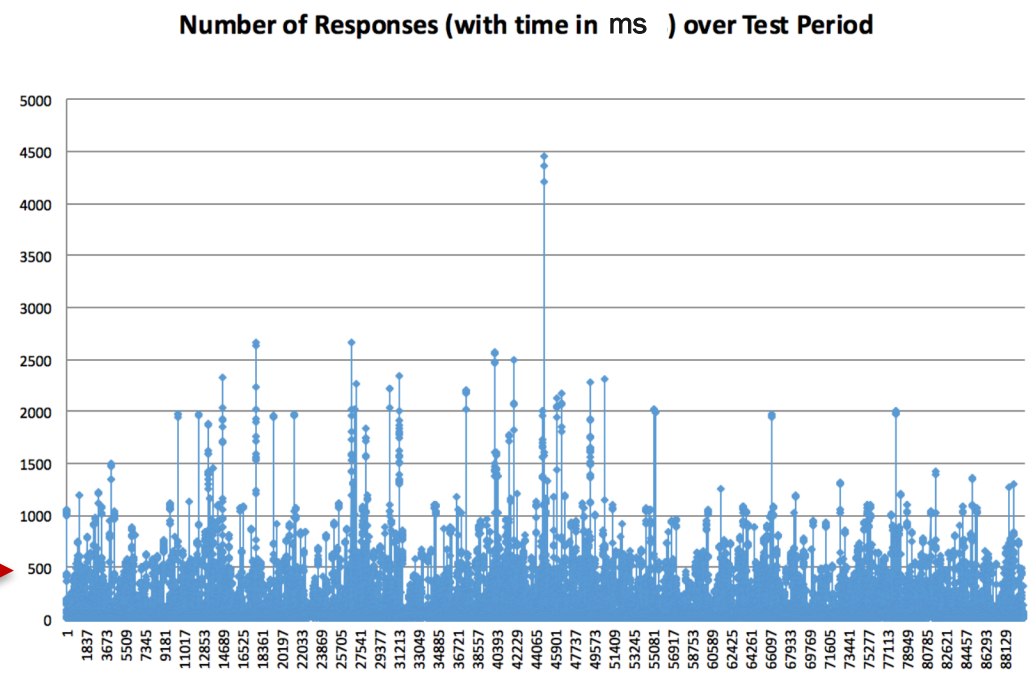


On premises implementation showed consistent performance during load testing vs more sporadic latencies in AWS.



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Technical Lesson 3

INVOLVE SECURITY FROM THE VERY BEGINNING

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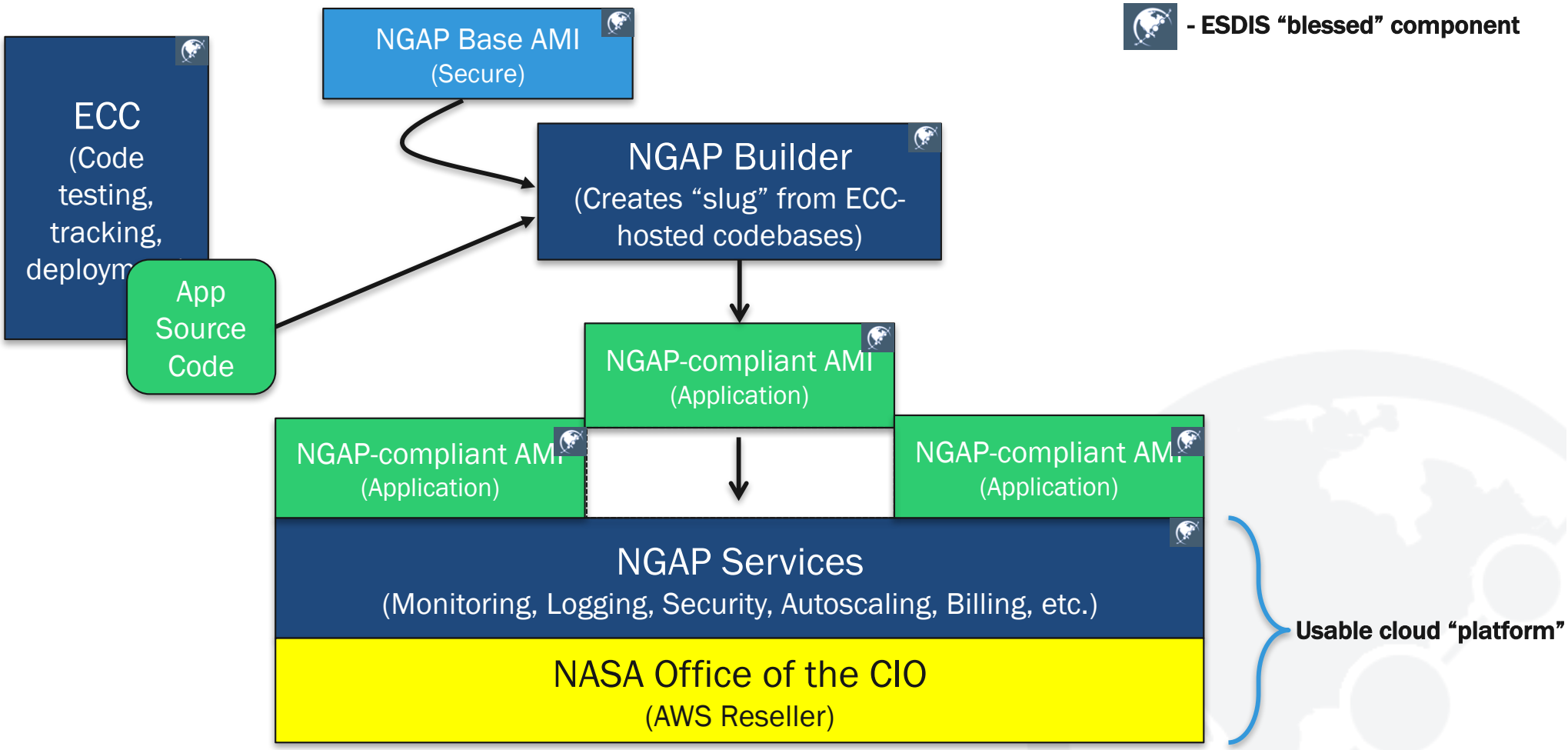
Layer security thoughout the architecture



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Cost Lesson 1

MODELING TOTAL COST OF OWNERSHIP (TCO) IS EXTREMELY COMPLICATED

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8	NGAP Application Profile	Web Application
9	Application Name	Earth Data Search
10	EC 2Instance Type	m4.xlarge; Tenancy: Shared; CPUs: 4; Memory: 16 GiB; Storage: EBS only: Cost: $0.239/Hrs
11	EC2 Instance OS Disk Size (GB)	8
12	EC2 Instance OS Disk type	General Purpose SSD
13	EC2 Disk Provisioned IOPS	30
14	EC2 Disk IO Rate (million)	10
15	EC2 Number of Instances	2
16	EC2 Utilization Rate (% of day)	50%
17	RDS DB Engine (No BYOL)	PostgreSQL
18	RDS Deployment Option	Multi-AZ
19	RDS Instance Type	db.m1.xlarge; CPUs: 4; Memory: 15 GiB
20	RDS Disk Type	Provisioned IOP SSD
21	RDS Storage Capacity (GB)	500
22	RDS Provisioned IOPS	100
23	RDS IO Rate (million)	10
24	AWS Lambda Usage (million requests per month)	1.2
25	AWS Lambda Memory Requirement (GB)	0.5
26	AWS Lambda Average Duration per Request (Seconds)	1
27	S3 Storage (TB)	3358
28	S3 PUT, COPY, POST, or LIST Requests per month	1000000
29	S3 GET and all other Requests	1000000
30	Cloudfront Egress (GB)	TBD
31	Dynamo DB Writes per Second	12
32	Dynamo DB Reads per Second	12
33	Dynamo DB Storage (GB)	1
34	DynamoDB Stream Requests (per month)	5000000
35	SQS Requests per Month (Each <= 64kb, A 100kb message is 2 requests)	2000000
36	SNS Mobile Push Messages	2500000
37	SNS Email	8500
38	SNS HTTPS	1300000
39	SNS Egress	TBD
40	CloudWatch Dashboards	1
41	CloudWatch Detailed Monitoring EC2	1
42	CloudWatch Custom Metric	6
43	CloudWatch Alarms	20
44	CloudWatch API Requests	120000
45	CloudWatch Logs Ingested (GB)	3.2
46	CloudWatch Logs Archived (GB)	3.2
47	CloudWatch Egress	TBD
48		
49	Environment Scaling	
50	Production Regions	2
51	UAT/Production Cost Ratio	1
52	SIT/Production Cost Ratio	1
53	DIT/Production Cost Ratio	0.5

Output	
	Ur
EC2	Instance (hr)
EC2	Storage(GB)/M
EC2	IOPS per GB M
EC2	IO Rate (millio
RDS	Instance (hr)
RDS	Storage(GB)/M
RDS	IOPS per GB M
RDS	IO Rate (millio
Lambda	Million reques
Lambda	GB-Seconds
S3	
First 1 TB / month	
Next 49 TB / month	
Next 450 TB / month	
Next 500 TB / month	
Next 4000 TB / month	
Over 5000 TB / month	
S3 Non GET Requests	Requests per r
S3 GET	Requests per r
Cloudfront	Egress GB
DynamoDB	Writes/Hour
DynamoDB	Reads/Hour
Dyanmo DB	Storage(GB)/M
Dynamo DB	Stream Read R
SQS	per request
SNS	Mobile Messag
SNS	Email Message
SNS	HTTP (m)
SNS Egress	
CloudWatch	Dashboard
CloudWatch	Detailed/instar
CloudWatch	Metric/month
CloudWatch	Alarm/month
CloudWatch	Requests (100
CloudWatch	GB
CloudWatch	GB
CloudWatch	Egress GB

Calculator | Cost Summary | NGAP Profiles | EC2 Data | RDS Data | Storage Data | Lambda Data | DynamoDB data | SQS Data | SNS Data | Cloudwatch Data | +

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NOVEMBER 1st-3rd Announcements!

Most Recent Announcements from AWS

Date	Announcement
Nov 03	Now run real-time stream processing at scale with Apache Flink on Amazon EMR
Nov 03	AWS CodePipeline Introduces AWS CloudFormation Deployment Action
Nov 03	Continuously Deliver Changes to AWS CloudFormation Stacks with AWS CodePipeline
Nov 03	Amazon Lumberyard Beta 1.6 now available, introduces Twitch Metastream and more
Nov 02	Amazon RDS for Oracle now supports 11g to 12c Major Version Upgrade
Nov 02	AWS Directory Service for Microsoft Active Directory (Enterprise Edition) is now available in the US East (Ohio) Region
Nov 02	Amazon CloudWatch Events is now available in the China (Beijing) AWS region
Nov 02	Amazon SES Now Provides Fine-Grained Email Sending Metrics
Nov 02	Backup to AWS with HP Data Protector 9.07 using Storage Gateway VTL
Nov 01	Swift Web Applications on the AWS Cloud: Quick Start Reference Deployment

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This is before considering…

- User behavior
- Staff cost savings
- Development cost savings
- Inter-region costs
- Data lifecycle modeling
- Application migration costs – both in and out
- Managing “consumption” based cost model

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Cost Lesson 2

EXPLORE ALTERNATIVE ARCHITECTURES FOR POSSIBLE COST SAVINGS

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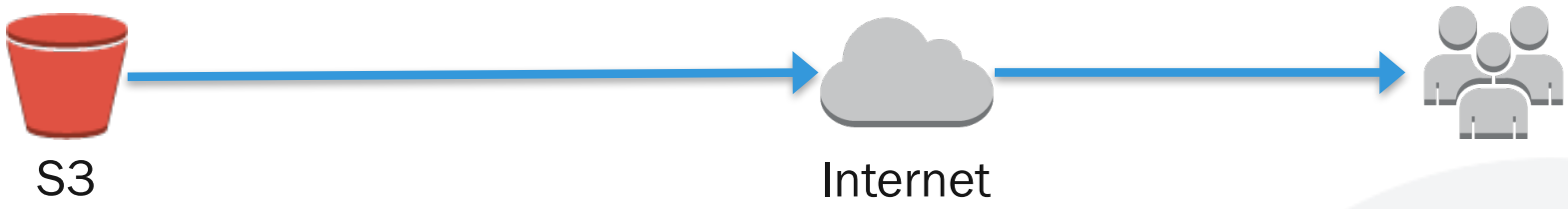
Basic S3 Egress



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S3 with CloudFront

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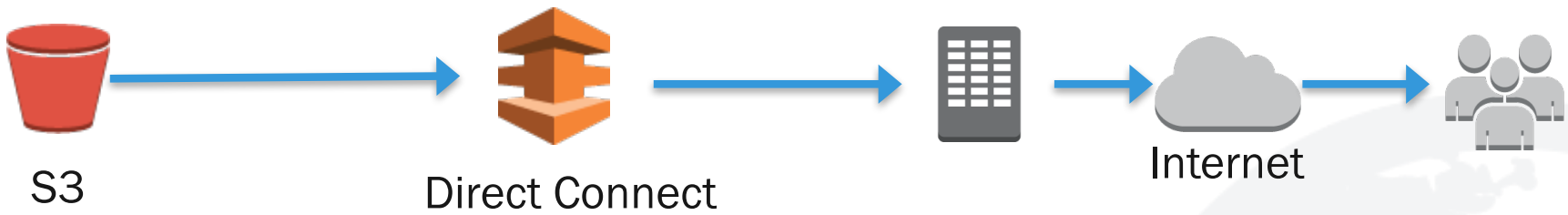
S3 through Direct Connect to On-premises Distribution Pipe



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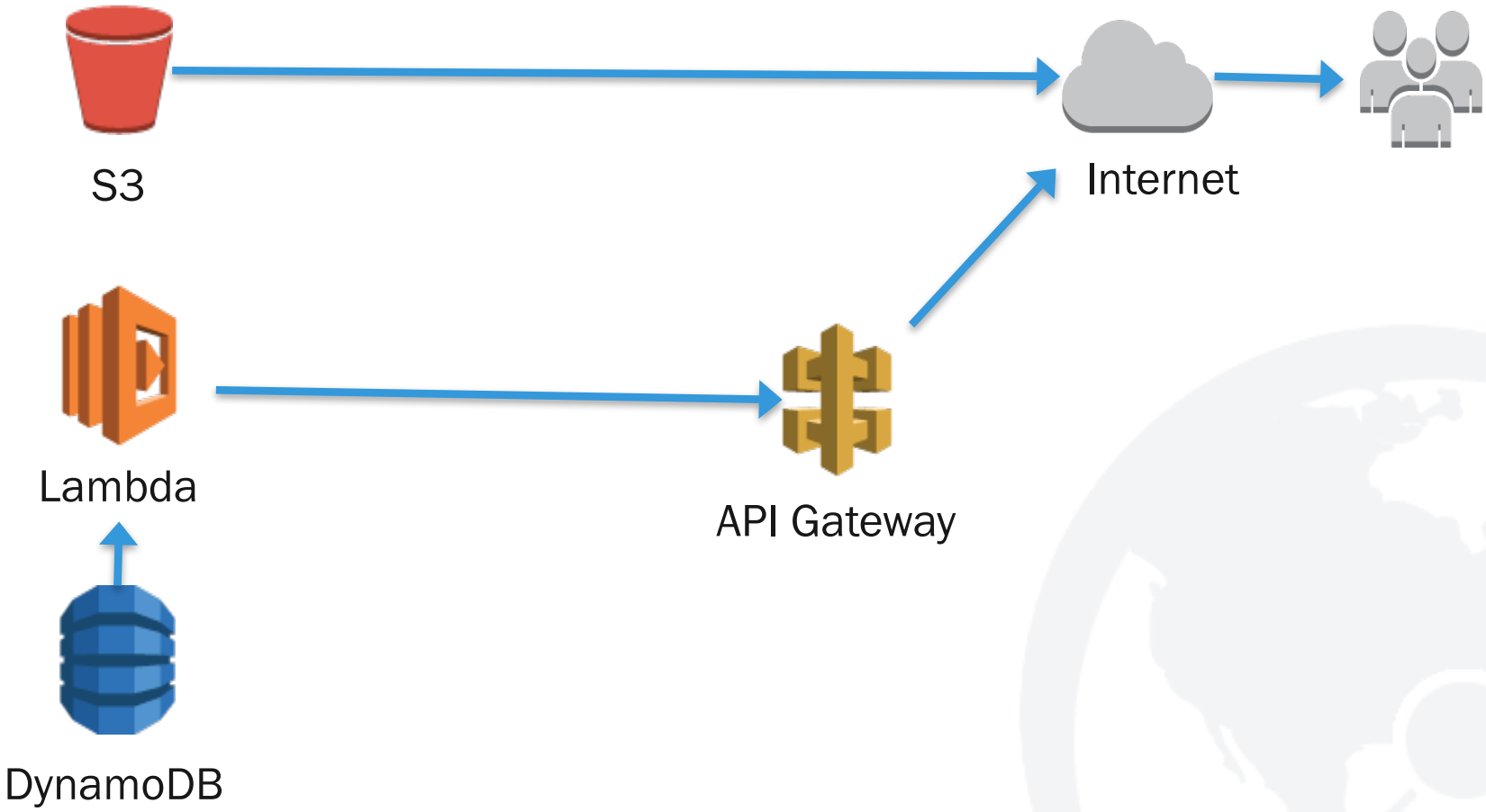
Request Limiting using Lambda and API Gateway



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Egress costs range more than 13x across those models.

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Psycho-Social

GO HANDS-ON QUICKLY

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EED2
HACKFEST
2016
CAPABLE OF
SPENDING ENTIRE
ANNUAL BUDGET


EED2
HACKFEST
2016
MOST LIKELY TO
GO INTO
OPERATIONS


EED2
HACKFEST
2016
MOST
INNOVATIVE


EED2
HACKFEST
2016
MOST
POINTS

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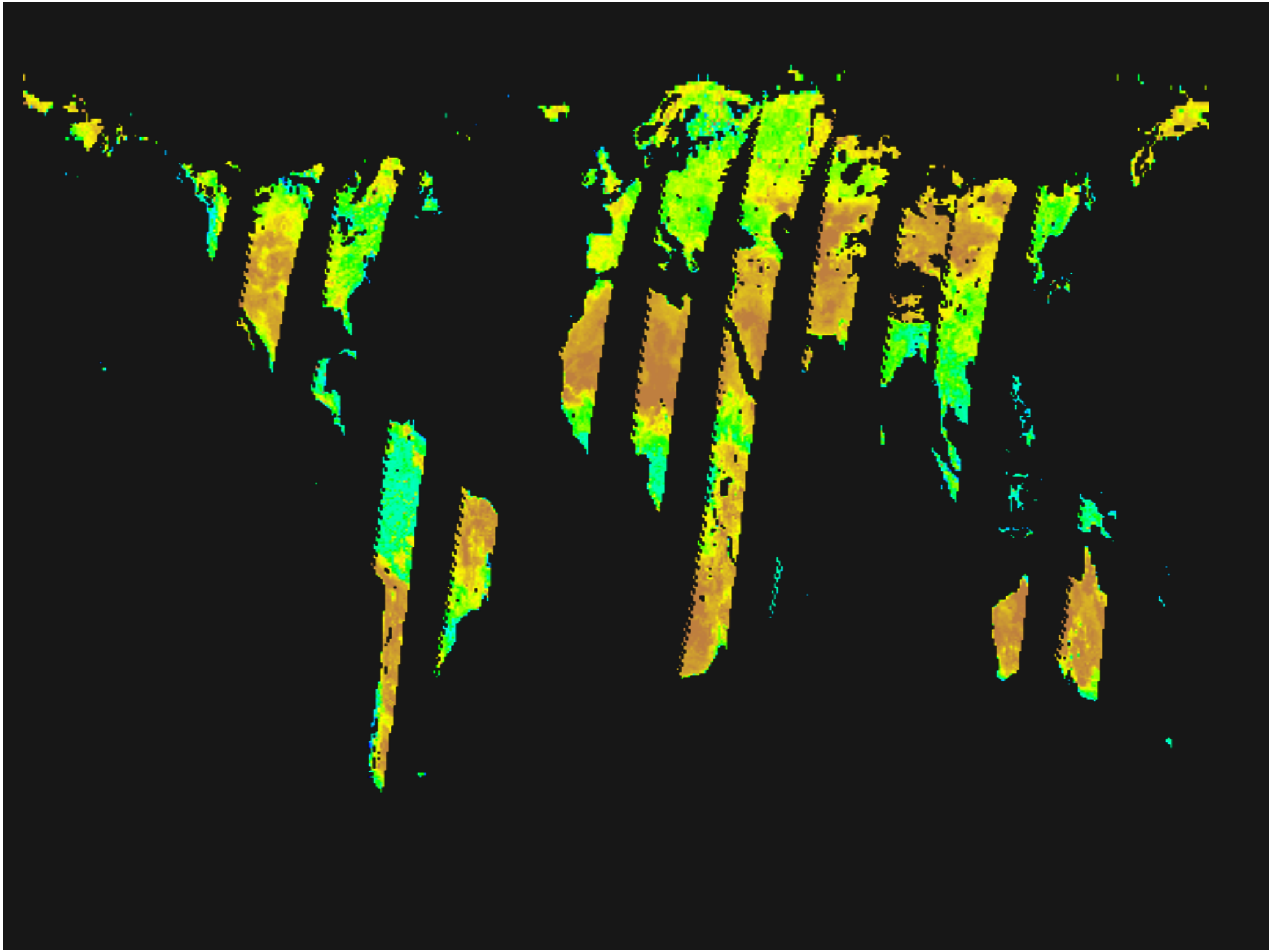

Psycho-Social

UNDERSTAND THE OPERATIONS TEAM'S NEEDS

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Current procedures may not translate directly

- Tailing / Grepping logs
- SSHing into machines to start / stop /restart services
- Monitoring specific hostnames
- Existing “operations” scripts
- Current dashboards vs AWS Console

Understand WHY they do what they do – you may need to find another way to do it.

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Summary

- Enable cloud native architectures by strongly preferring cloud services
- AWS has very low internal latency, but trust nothing.
- Involve security from the very beginning
- Modeling TCO is extremely complicated
- Explore alternative architectures for possible cost savings
- Go hands-on quickly
- Incorporate Operations' Needs

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Questions?

Dan Pilone
dan@element84.com

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