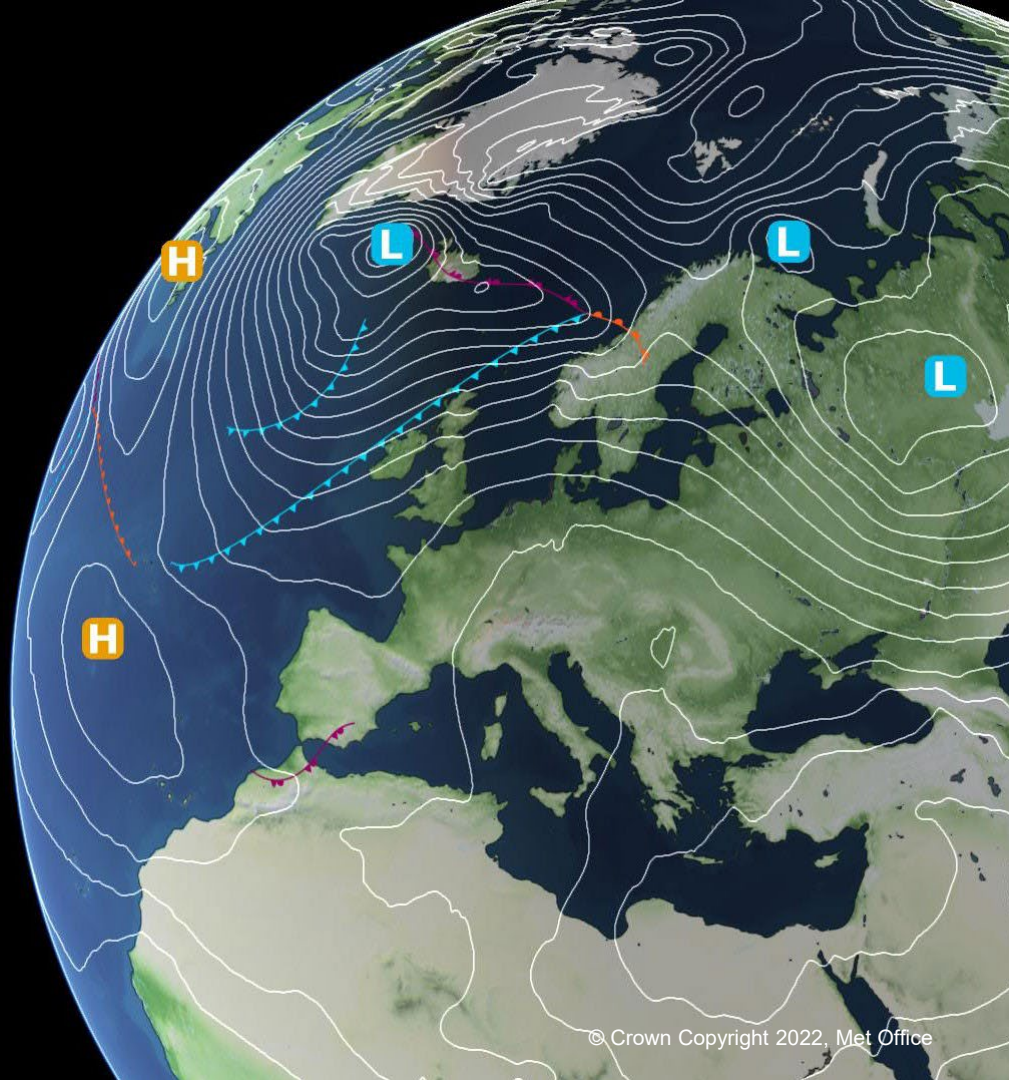
Met Office

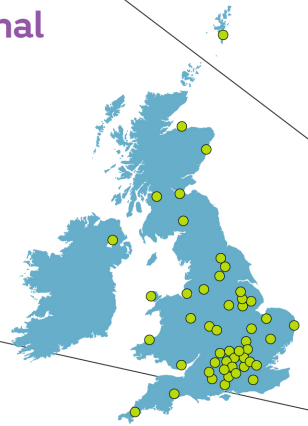
Modelling clouds in the cloud

Rich Lawrence

September 2022

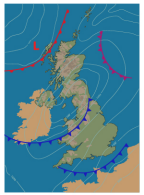


National

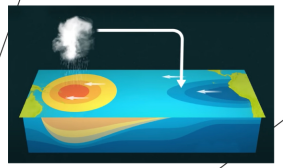


Multi-hazard

Weather



Science



Government

Department for Business, Energy & Industrial Strategy

Department for Environment Food & Rural Affairs

Department for Transport

Ministry of Defence

Foreign, Commonwealth & Development Office

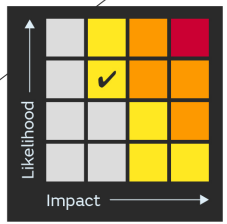
Civilian

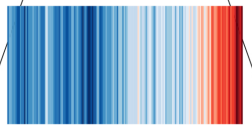
14:1 ROI

Military

Civil Aviation Authority

THE CHAMPIONSHIPS WIMBLEDON





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WORLD METEOROLOGICAL ORGANIZATION

WISER
Weather and Climate Information Services for Africa

ARRCC
Asia Regional Resilience to a Changing Climate

Industry

Services

Climate

Meteorology

International

Met Office

Our strategy – how it fits together

Our purpose:
Why we exist

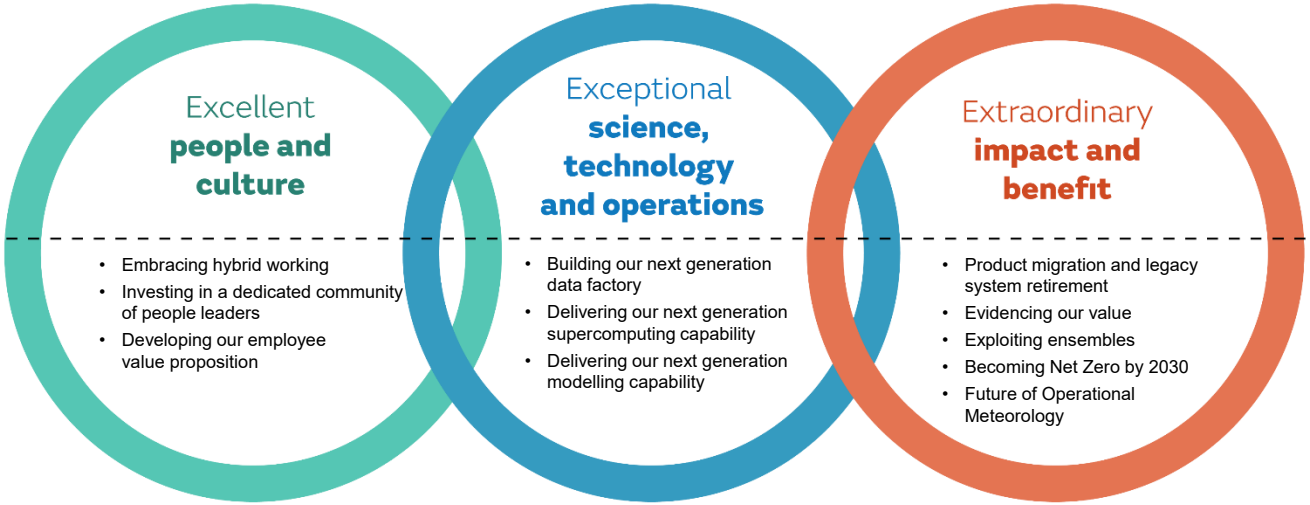
Helping you make better decisions **to stay safe and thrive**

Our vision:
What we are working towards

Recognised as global leaders in weather and climate science and services in our changing world.

Strategic anchors:

Our three focus areas which overlap and complement each other



Strategic actions:

Our priority activities which we'll monitor and measure

- Embracing hybrid working
- Investing in a dedicated community of people leaders
- Developing our employee value proposition

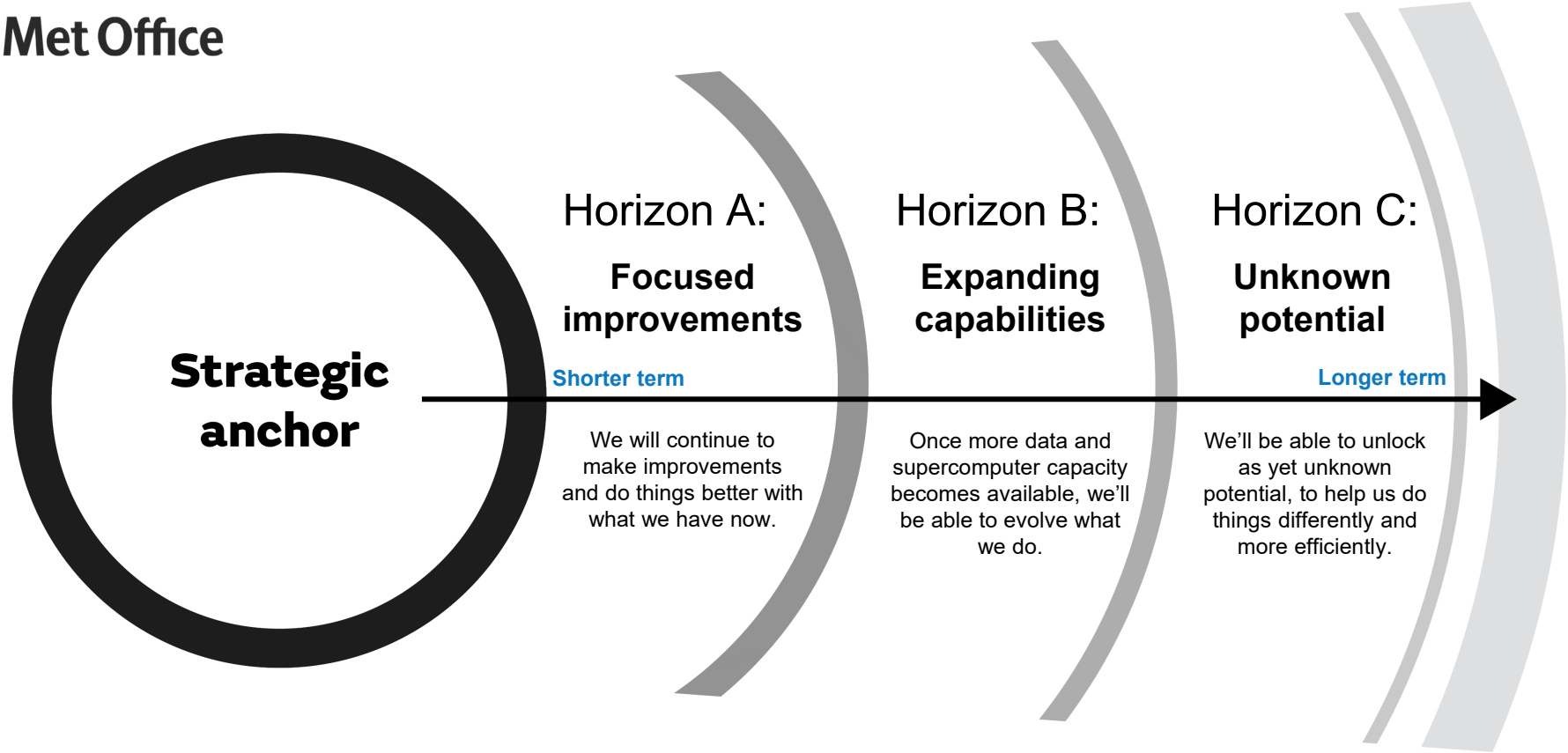
- Building our next generation data factory
- Delivering our next generation supercomputing capability
- Delivering our next generation modelling capability

- Product migration and legacy system retirement
- Evidencing our value
- Exploiting ensembles
- Becoming Net Zero by 2030
- Future of Operational Meteorology

Our value proposition:
What makes us unique

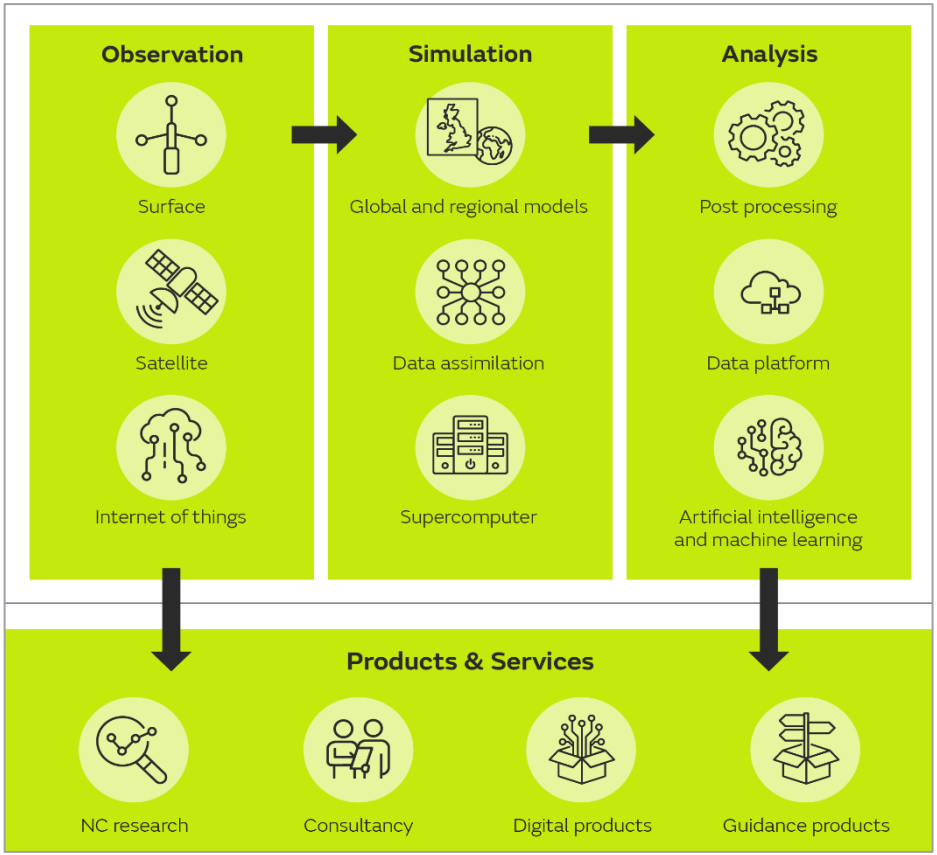
Pioneering science, trusted services and global impact

Our values:
Who we are



We have now identified a number of 'horizons' for each anchor to move us toward to our vision.

National Capability



Total Capability:
12.6 Petaflops
5.2-5.5MW
460,672 Cores
1.6PB RAM
27PB Sonnexion

HPC1

Name: XCE
Cray XC40
2.8 Petaflops
1.5MW
109,376 Cores*
385TB RAM
4PB Sonnexion

IT Hall 1

HPC2

Name: XCF
Cray XC40
2.8 Petaflops
1.5MW
109,376 Cores*
385TB RAM
9PB Sonnexion

IT Hall 2

*89,856 Broadwell, 19,520 Haswell

HPC4: XCK

HPC4: XCT

HPC4: GW4

Auxiliary Test Systems:
XCK: Knights Landing
XCT: Test XC40
GW4: Shasta Testbed

HPC3

Name: XCS
Cray XC40
7 Petaflops
2.2-2.5MW
241,920 Cores*
840TB RAM
14PB Sonnexion

IT Hall 3

*Broadwell


Cray XC40
2015-2022
15,600,000,000,000,000 FLOPS

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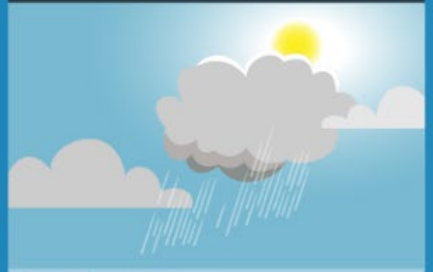
Supercomputing 2022+

Replacing and increasing supercomputing capacity to...

Keep UK expertise at the **forefront of global weather** and **climate science**



Strengthening:
- global leadership
- international partnerships
- our authoritative voice

Further inform our **understanding and analysis** of **climate change**

Understanding the climate pathways for a resilient net zero world

Enhance UK resilience to severe weather in a changing climate

Helping government, businesses and individuals to stay safe and thrive


Met Office
Value for Money…
investment
£1.2bn
10 year investment period
return up to
£13.7bn
of socio-economic benefits

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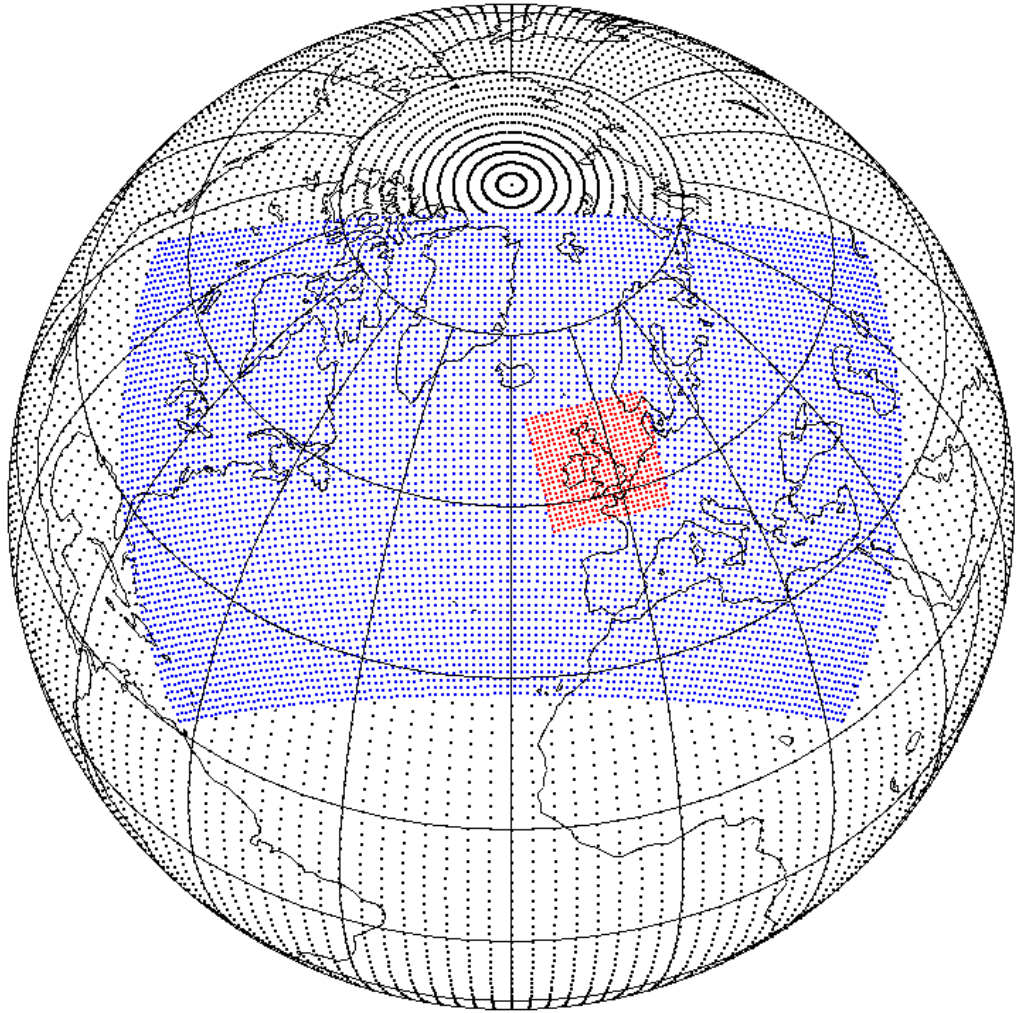


Next Generation Modelling Systems

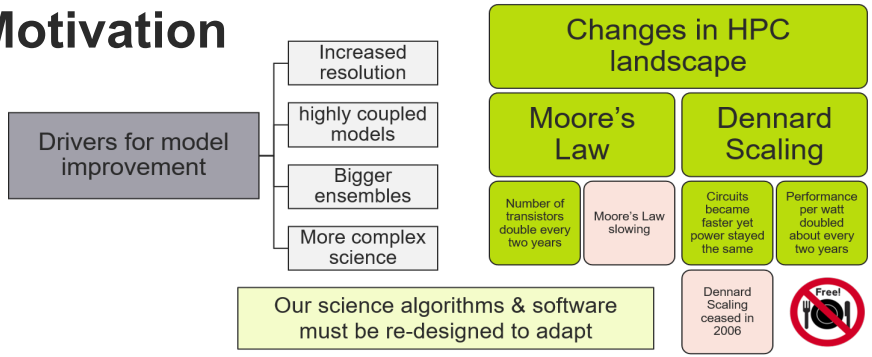
STRATEGIC ACTION

Delivering next-generation modelling capability

Programme vision

"To reformulate and redesign our complete weather and climate research and operational / production systems, including oceans and the environment, to allow the Met Office and its partners to fully exploit future generations of supercomputer for the benefits of society."

Motivation

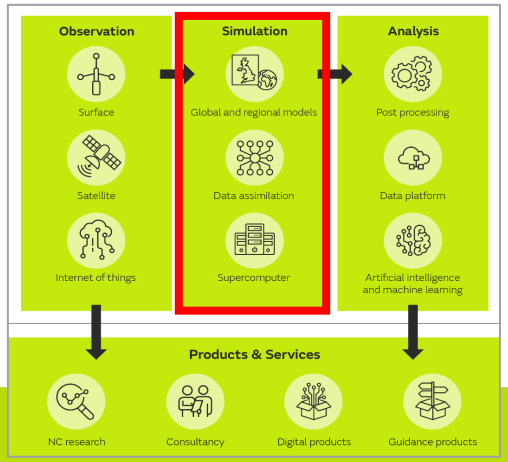


Progress to date

- **Working new global simulations**
- **New partnerships**
- RSE skills/training

NGMS Benefits

- Improved scalability
- Fully exploit Generation 2 HPC
- Enable new science
- Grow external collaborations



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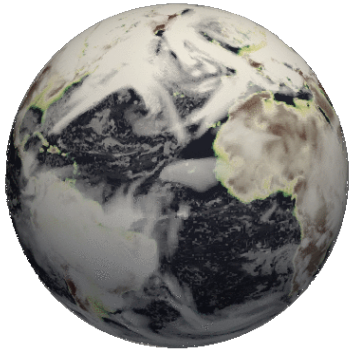


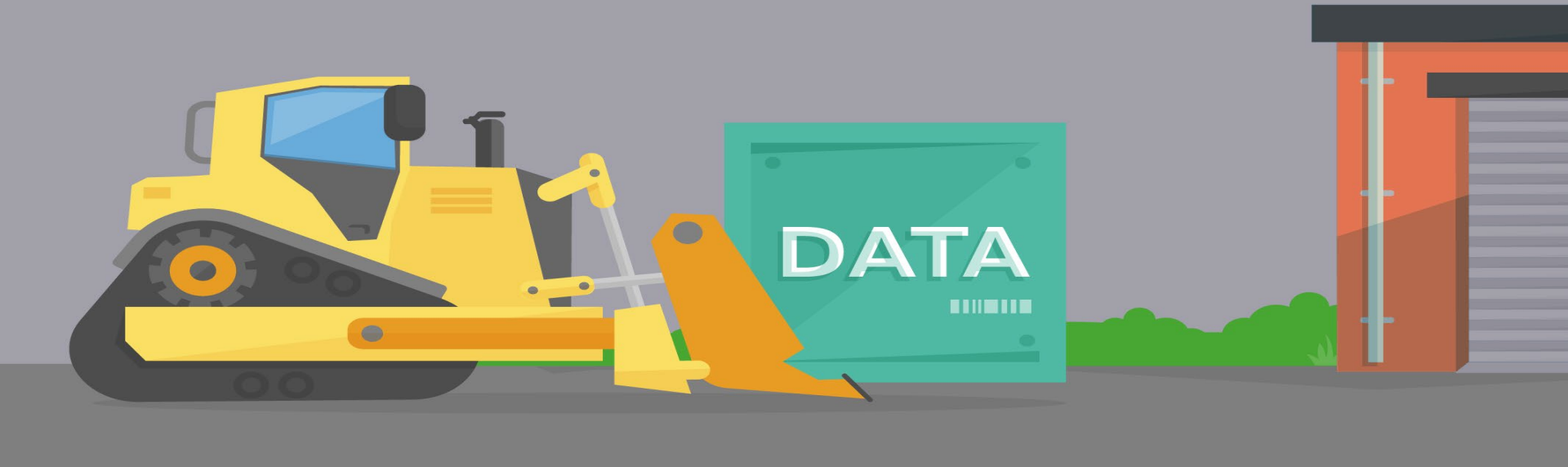
Maintain accuracy

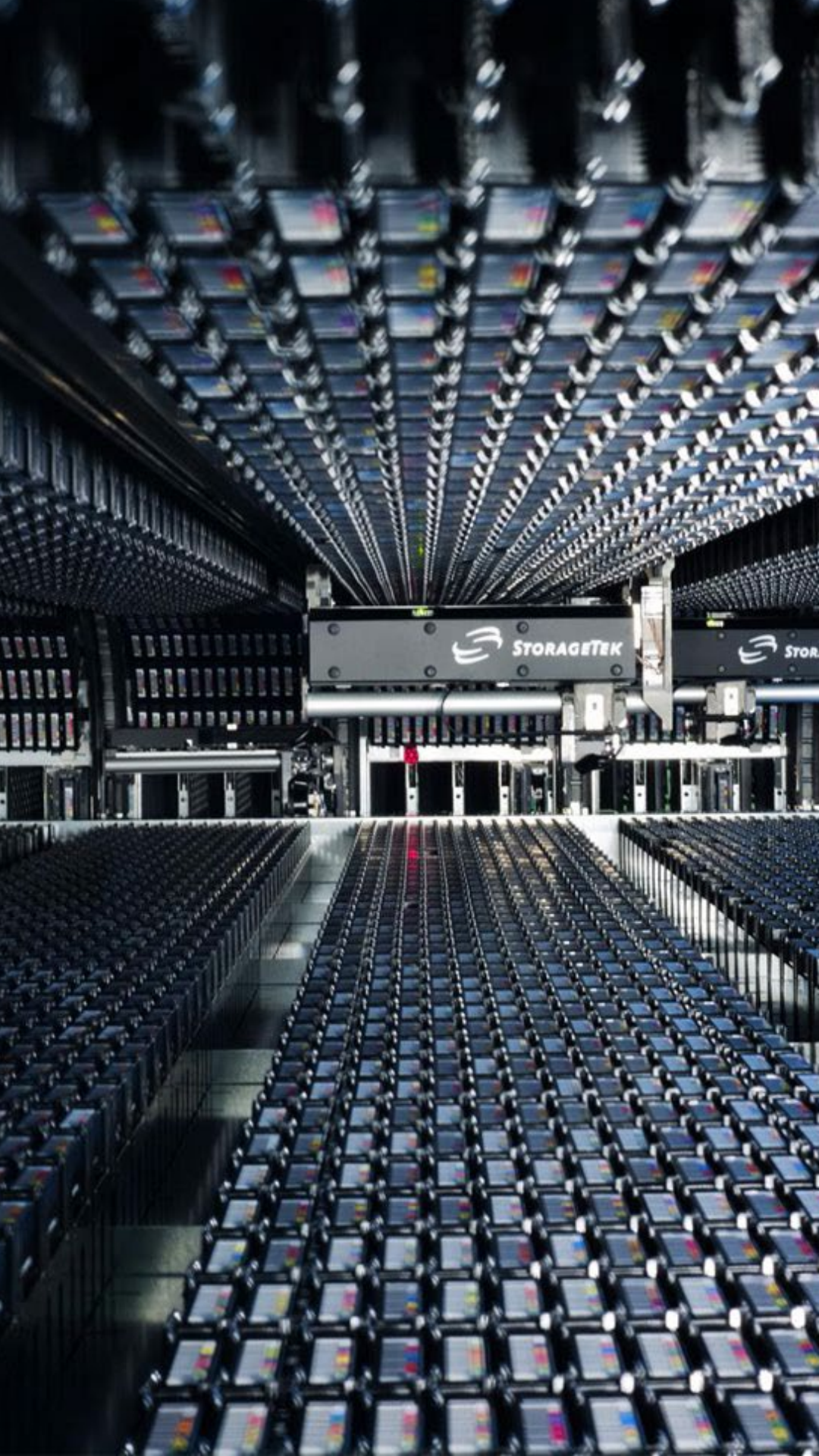
Improve scalability
Exploit other programming models

Lon-lat grid (Poles) *structured*
Finite-difference
Hard-coded optimisations

Cubed-sphere mesh – unstructured
Mixed finite element method
Generated optimisations

Met Office Data Challenge




StorageTek

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Approach

- Replace Supercomputer every 5 years or so
- Data Archive procured separately
- Smaller computers procured separately
- Host everything on site

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Challenges

Power requirements to site

Aging Electrical infrastructure

Procurement conveyorbelt

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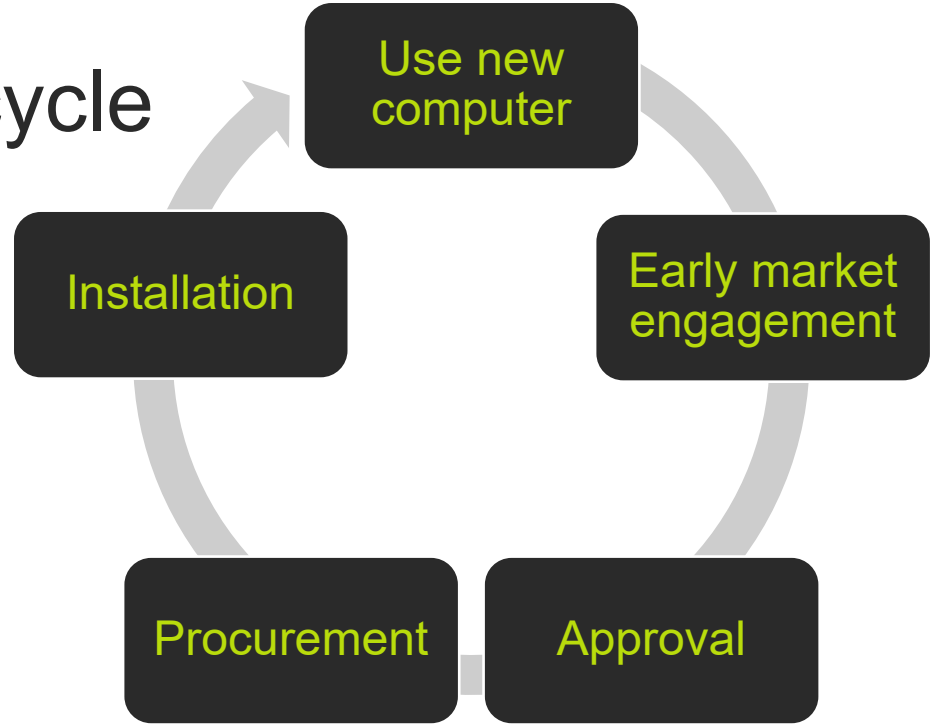
A new approach…

a new
fully managed
service delivery model

a world class technology
partner
with global reach

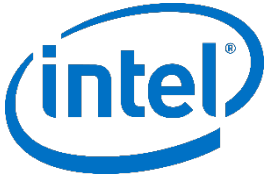
round the clock
24x7
integrated operation and support service

5 year cycle


Use new computer
Early market engagement
Approval
Procurement
Installation

Met Office

Early Market Engagement



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Approvals

GOV.UK

10 DOWNING STREET
LONDON SW1A 2AA

Department for Business, Energy & Industrial Strategy

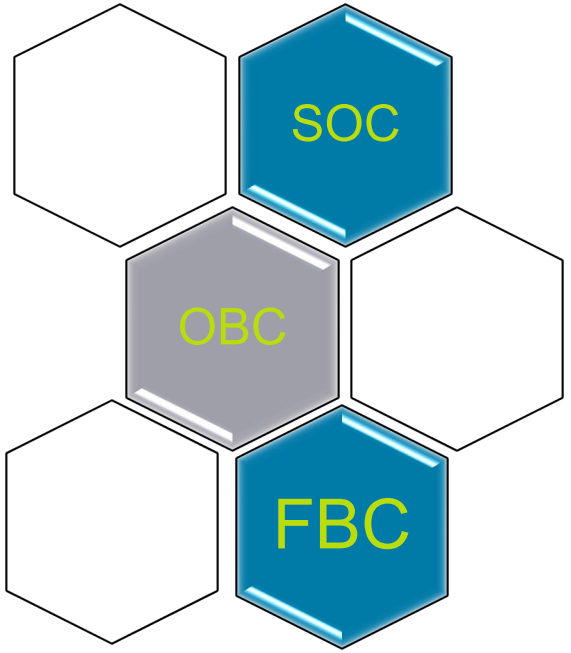
HM Treasury

Cabinet Office

Government Major Projects Portfolio

The business case

The Case	The question	What the Business Case must demonstrate	
Strategic Case	Is the proposal needed?	will it further the aims and objectives?	is there a clear case for change?
Economic Case	Is it value for money?	has a range of options been considered?	is it the best balance of cost, benefits and risk?
Commercial Case	Is it viable?	is there a supplier who can meet our needs?	can we secure a value for money deal?
Financial Case	Is it affordable?	are the costs realistic and affordable?	is the required funding available and supported?
Management Case	Is it achievable	are we capable of delivering the project?	do we have robust systems and processes in place?



Procurement

Requirements

- 6 packages of requirements
- 450 requirements in total
- 30 experts
- 1 year

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Procurement

Evaluation

- ~ 20 evaluators
- 4 rounds
- Dialogue meetings with suppliers
- Clarification questions

- Strict working conditions
- Lot of time working with Lawyers

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A new strategic collaboration…

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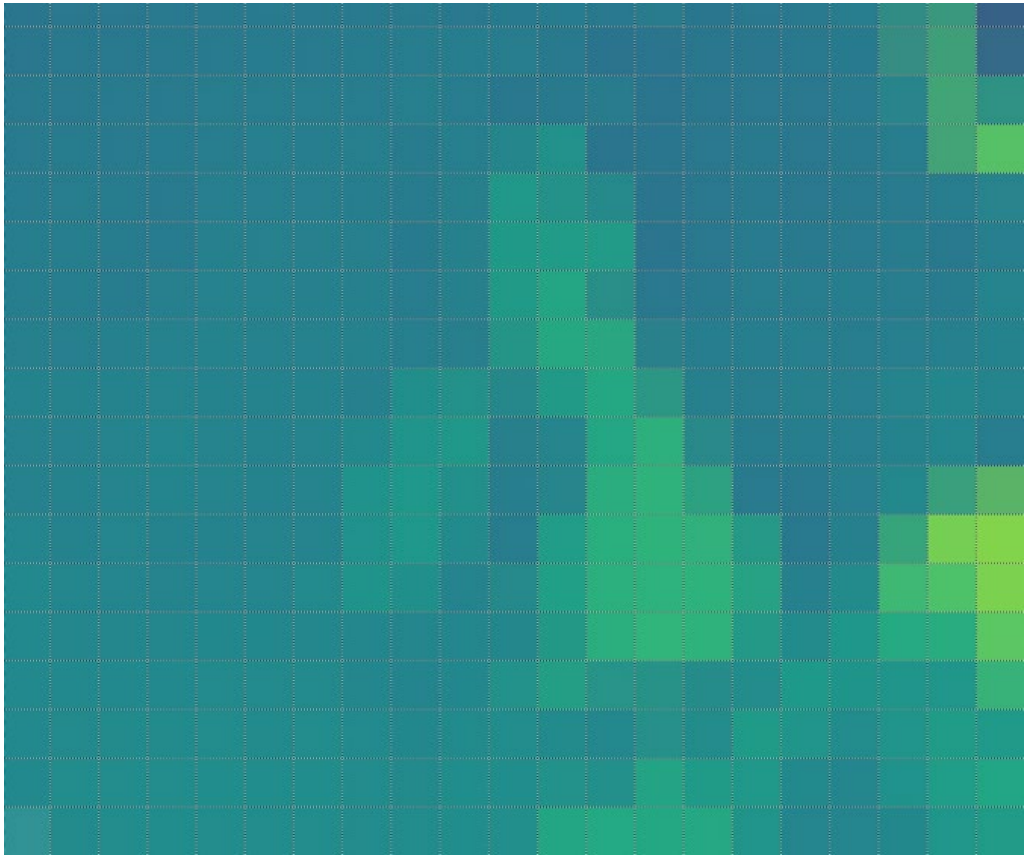

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Supercomputing 2022+

Replacing and increasing supercomputing capacity to...

2 generations of supercomputing refreshed after 5 years

Generation 1 — Generation 2

2022 | 2027 | 2032

Generation 1

6x

Phased introduction of capability

Phase 1a **Phase 1b**

By Jan 2023: Replace existing capacity and then increase to 6 x current capacity

Generation 2

~18x

Increase over current capability

Phase 2a **Phase 2b**

2027/28: Increase by further 3 x capacity

Creating one of the world's most environmentally sustainable supercomputing capabilities

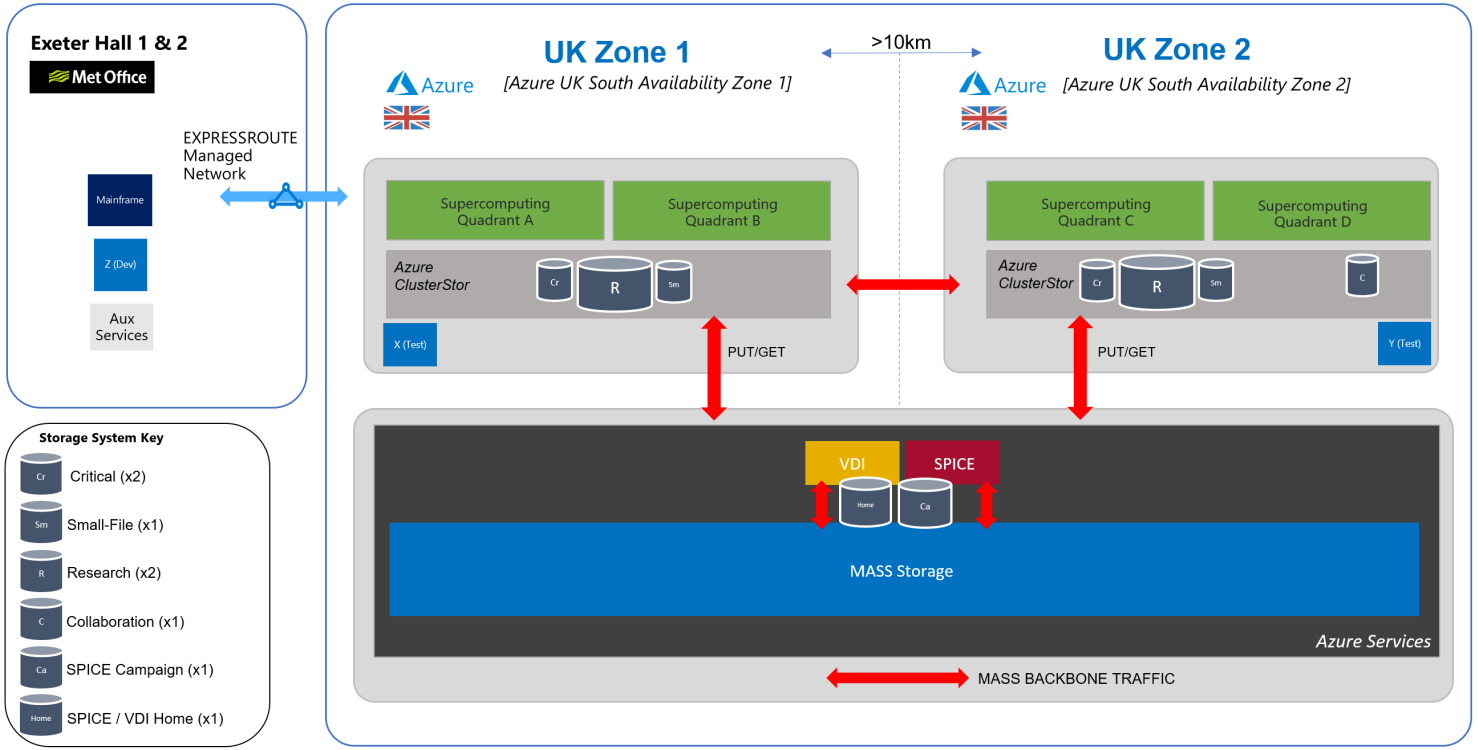
Powered entirely by sustainable energy

Based in the South of the UK

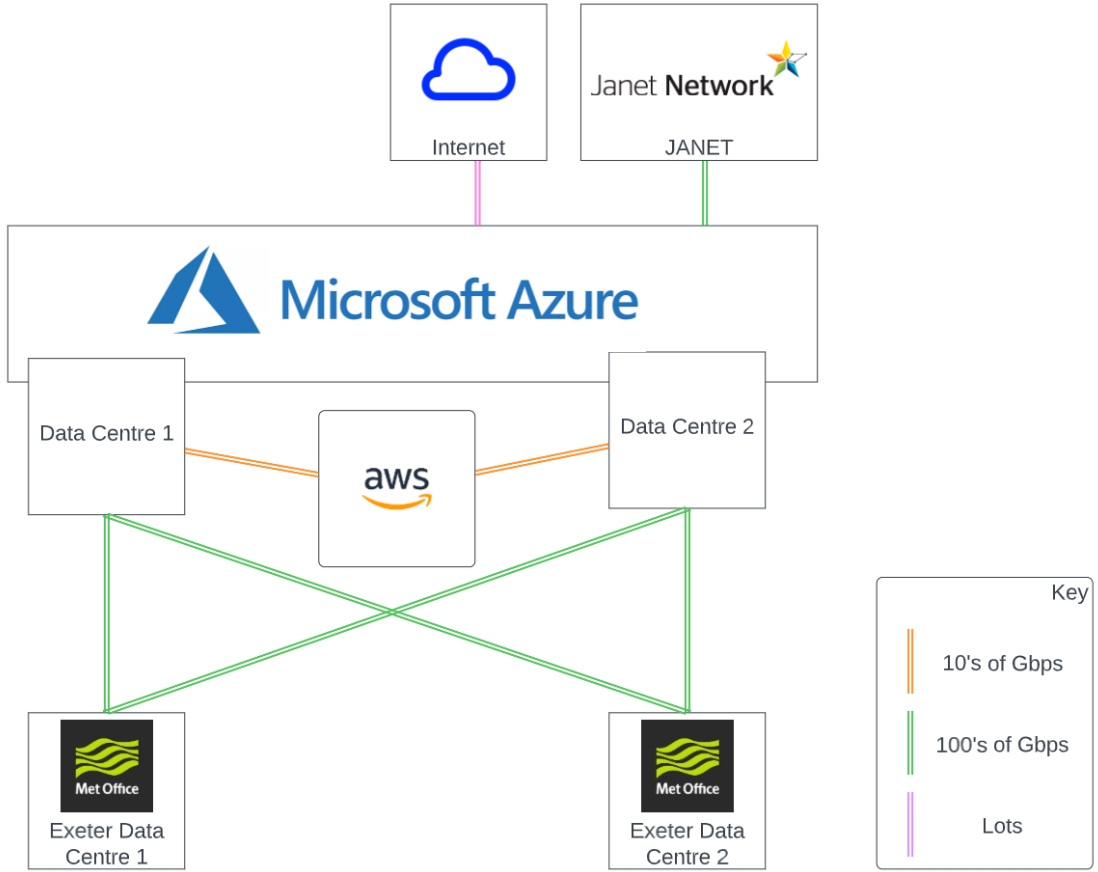
Full service supplied though a single provider

Service contract

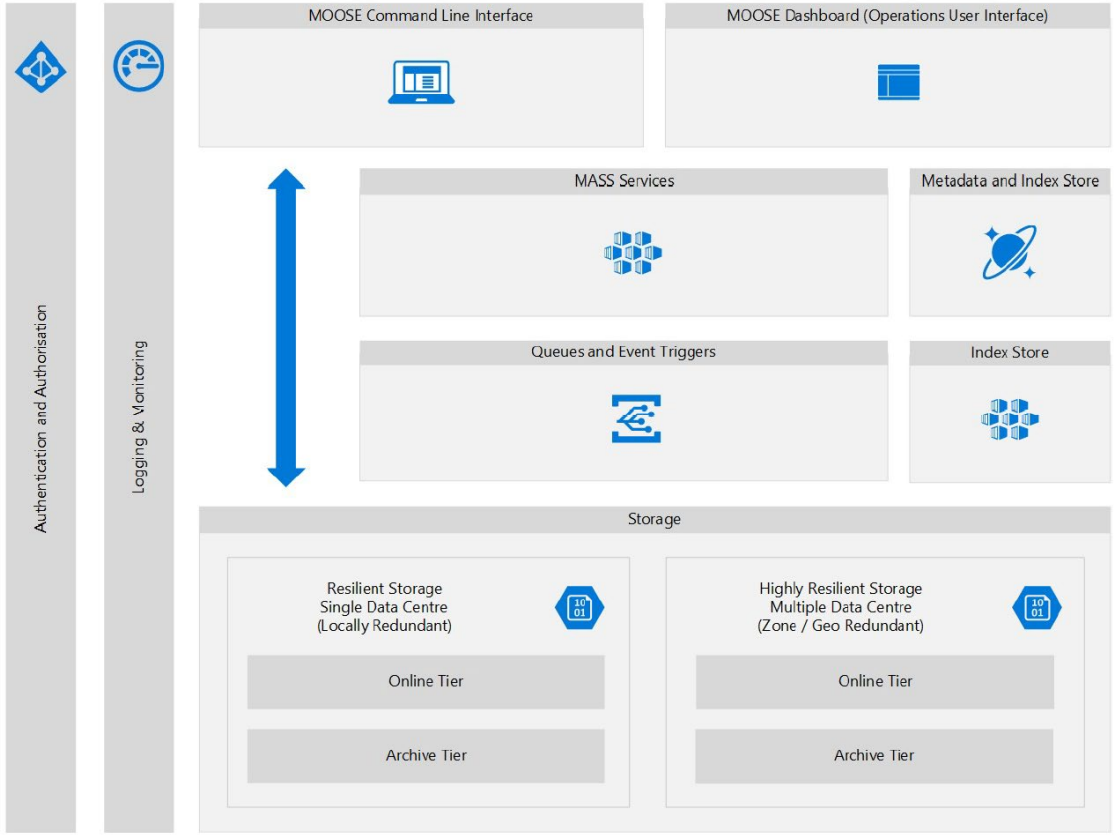
- Hosting
- Supercomputing
- Networking
- Data storage
- Scientific compute



Connectivity



MASS
Logical Architecture



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Our cloud journey

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It starts with a server

Just one

And then they grow…

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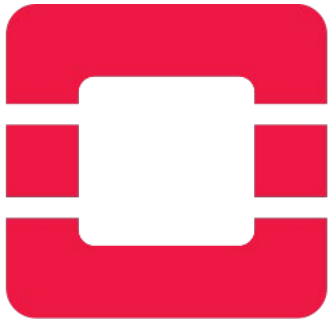
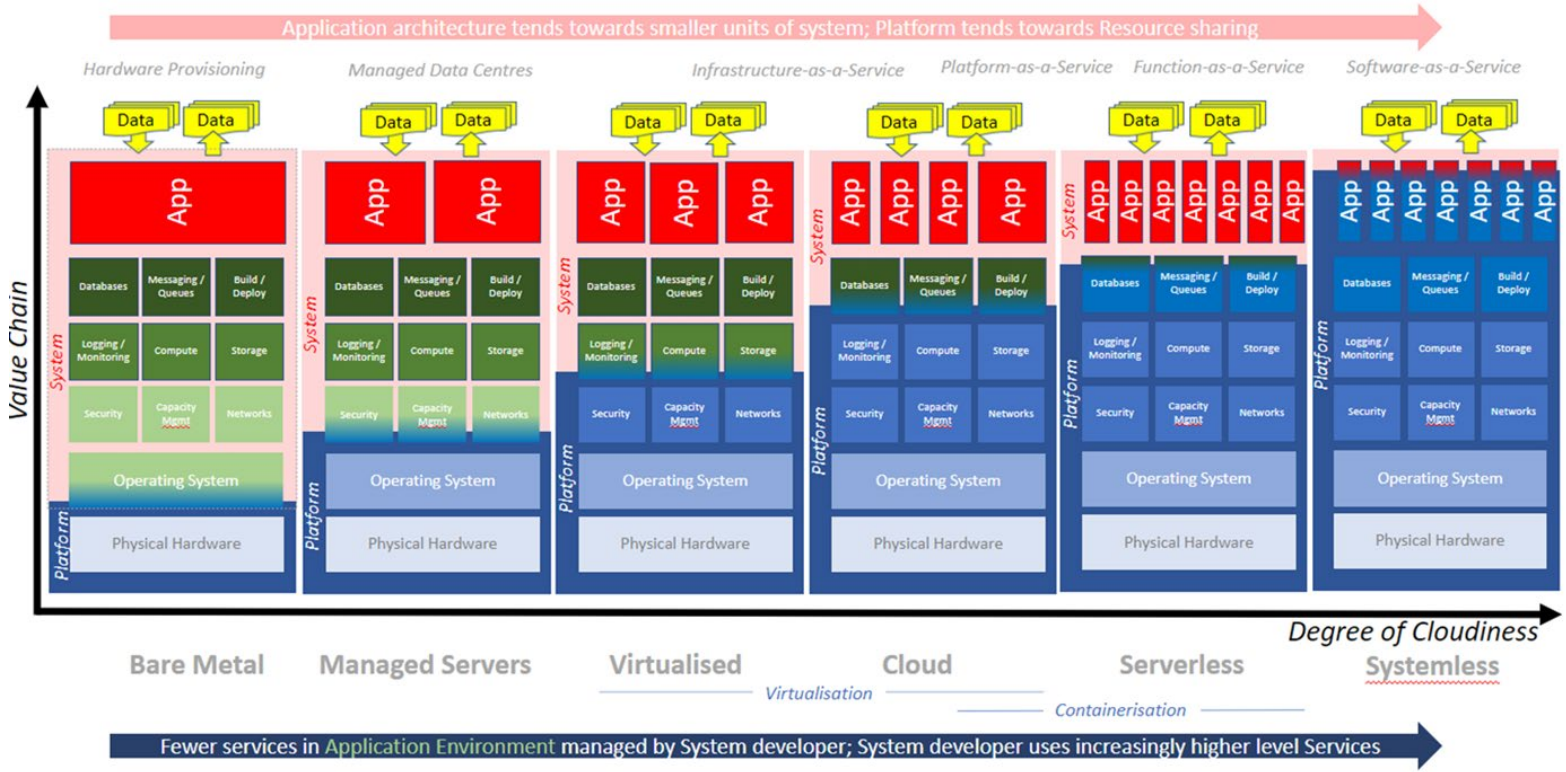


openstack®

The purpose of the Met Office is not to build servers

… we model the future!

by doing SCIENCE & operational Weather forecasting



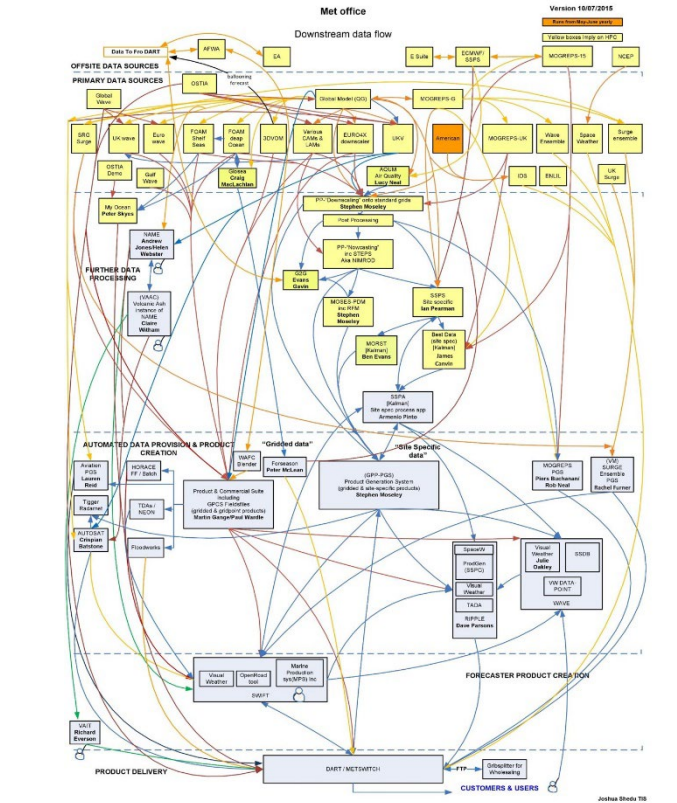
Met Office

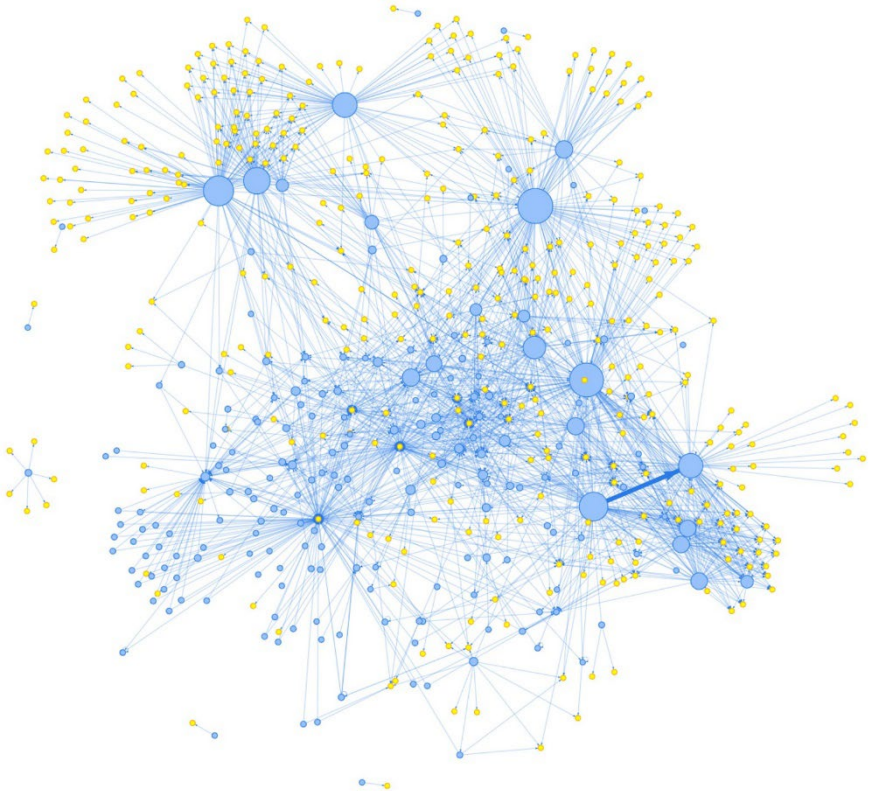
Charity Majors
@mipsytipsy

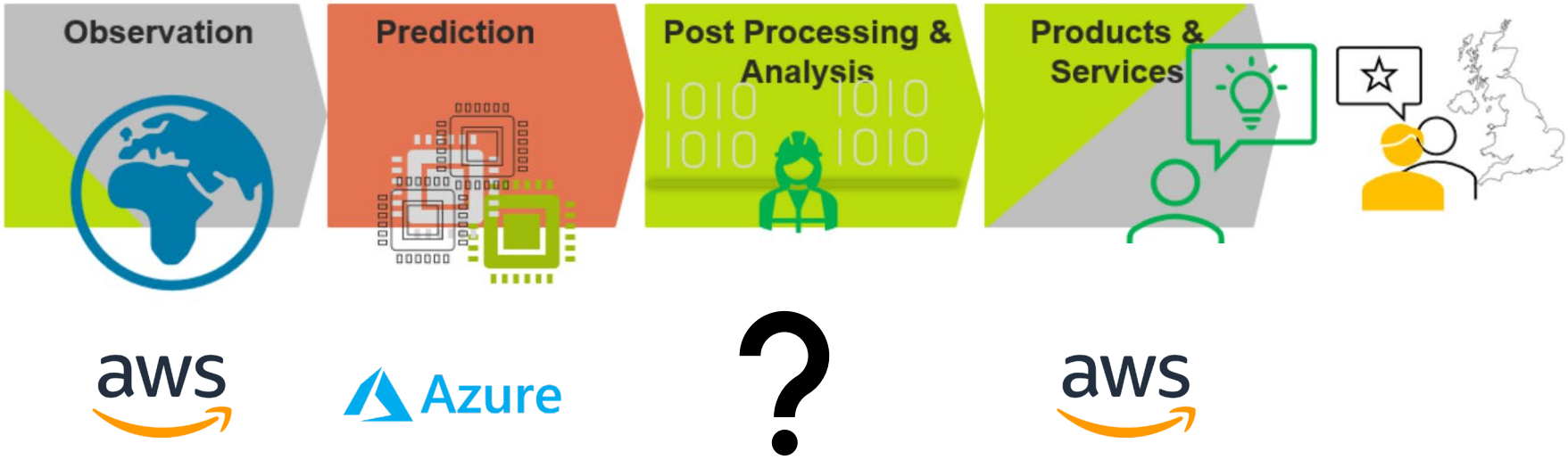
Follow

if you have hard/interesting problems, solving them will not be cheap or easy, ever.

1 — try not to have hard problems
2 — outsource any that aren't literally why your company exists
3 — rally your engs, carefully detail which ones you do exist to solve.. and turn them loose.







Analysis Platform

Post processing

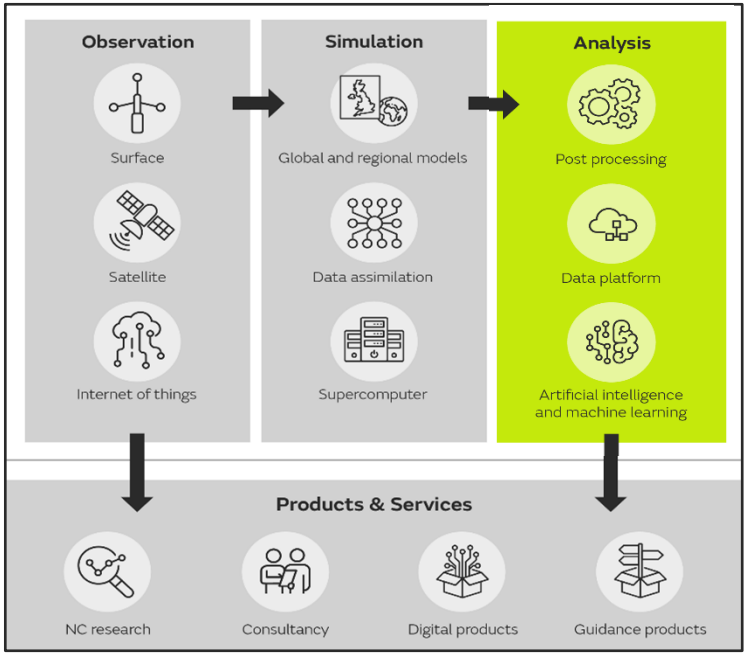
- Data gravity means application moves to data
- Need to mash up with new data sets – e.g., ONS

Data Platform

- Met Office choosing to utilise ‘as-a-service’, in preference to the traditional ‘own and operate’ model
- Bespoke data center vs cloud hyperscalers
- Aiming for a ‘platform of platforms’

Artificial Intelligence & Machine Learning

- Layer of machine learning onto model output



For more information please contact


@richlawrence


richard.lawrence@metoffice.gov.uk


http://uk.linkedin.com/in/richjohnlawrence/