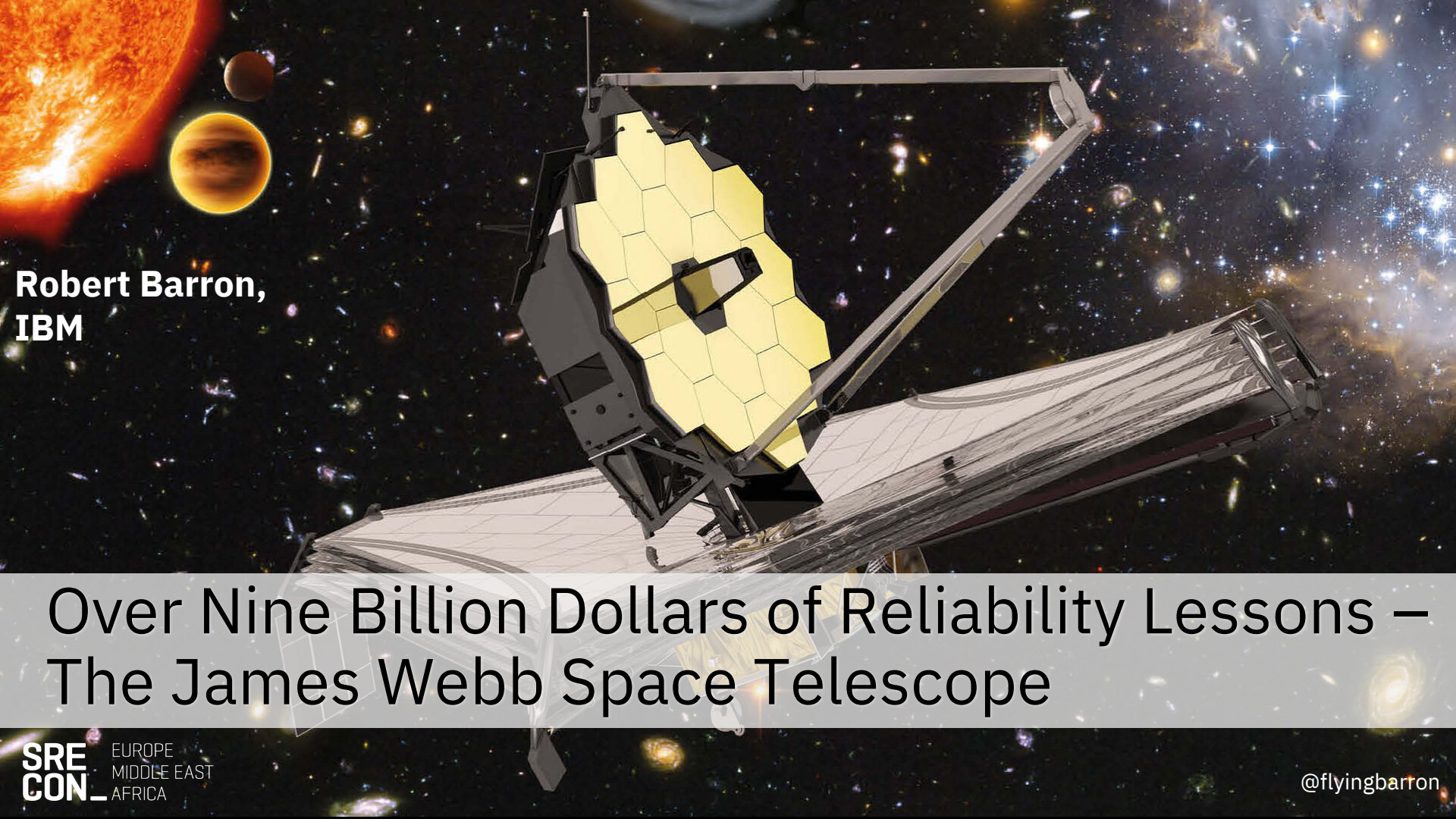


Robert Barron,
IBM

Over Nine Billion Dollars of Reliability Lessons – The James Webb Space Telescope

Me, IBM, SRE, Astronomy, and Space

@flyingbarron

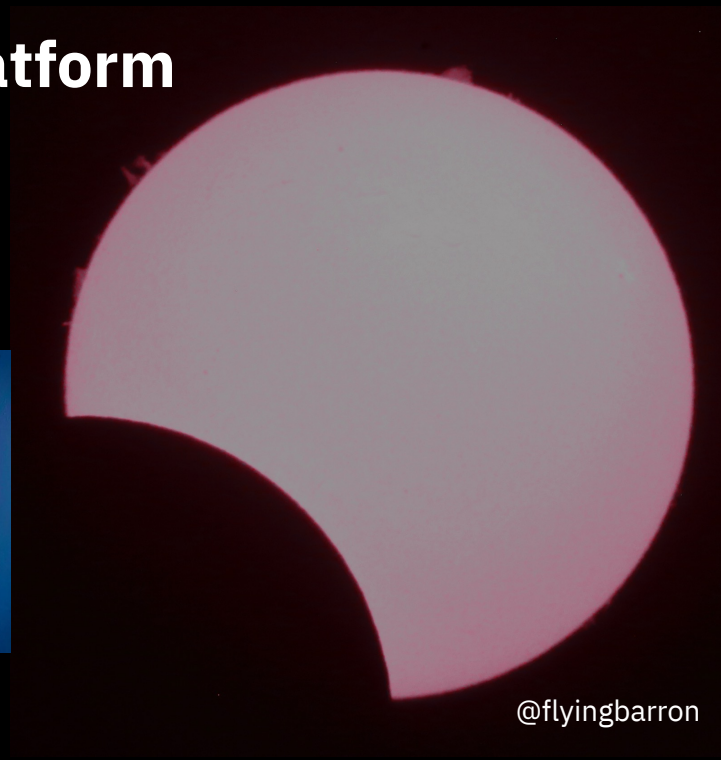
in Medium

brobert@il.ibm.com

IBM

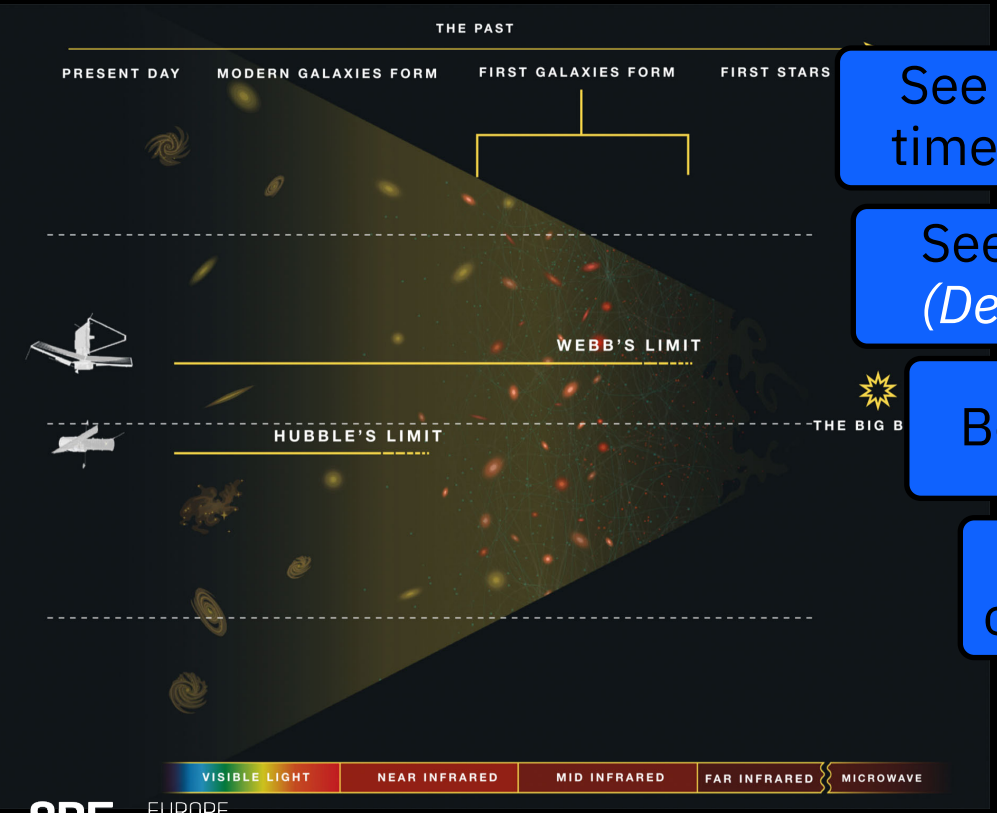
SRE Architect

IBM CIO Hybrid Cloud Platform



Why Webb? The functional requirements.

Functional requirements drive non-functional ones



NASA/ESA/CSA

See further back in time (*KPI for success*)

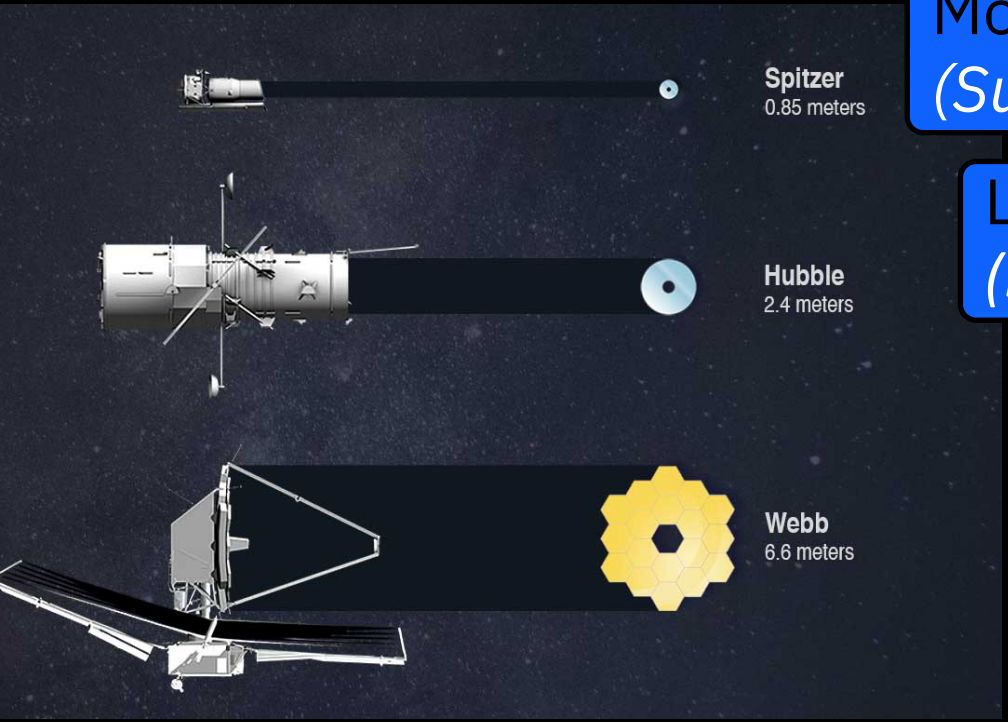
See in the infrared *(Dev. req.)*

Be colder *(Op. env.)*

Have precise temp. control *(Ops. controls)*

Have sunshade & remote orbit (*NFR*)

Functional requirements drive non-functional ones



NASA/ESA/CSA

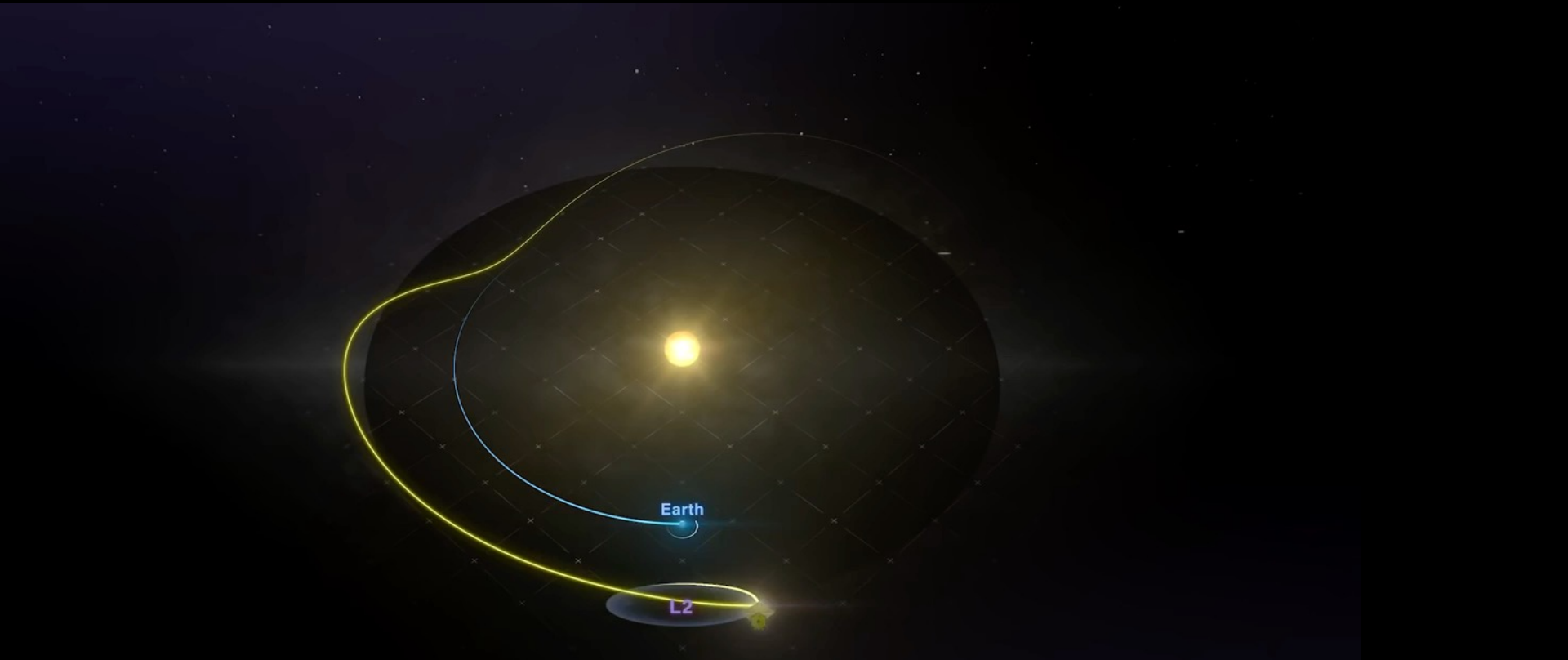
More capacity
(Success KPI)

Larger mirror
(Dev Req)

Mirror too large
(Ops. Const.)

Foldable mirror
(NFR)

Stable, but unreachable orbit



NASA/ESA/CSA

History of development

1990-today

Legacy Observatories

1995-2003

Kickoff

(1,000,000$)

2003-2007

High level design

for development

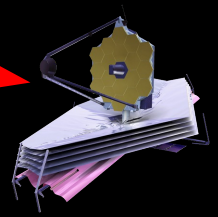
for 10 years of operations

Detailed design & construction

2007-2021

December 2021

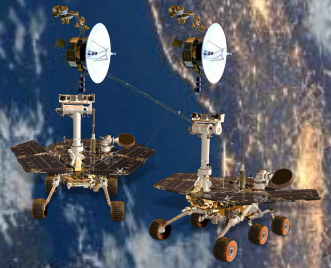
July 2022

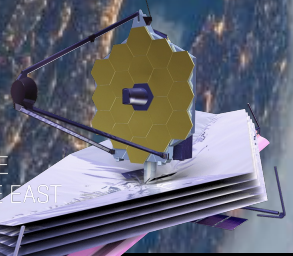


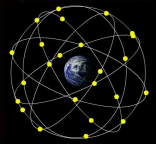
SRECON EUROPE MIDDLE EAST AFRICA

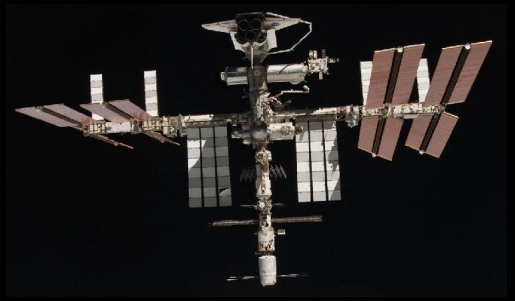
@flyingbarron

Where does the trust come from?









Redundancy

Repairability

Reliability

James Webb Space Telescope

James Webb Space Telescope

@flyingbarron

Reliability – a single point of failure?

There are 344 single-point-of-failure items...

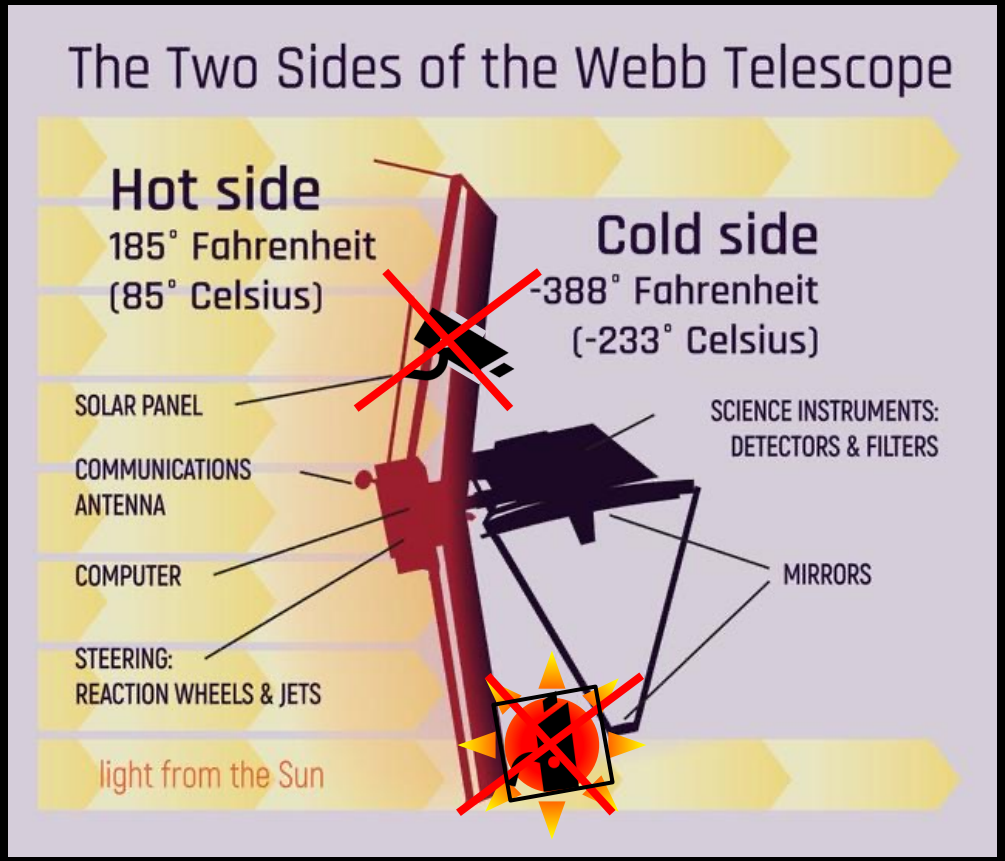
When we identify a single point failure, we give it very special treatment.

We have what we call a critical item control plan, and we always throw in extra inspection points.

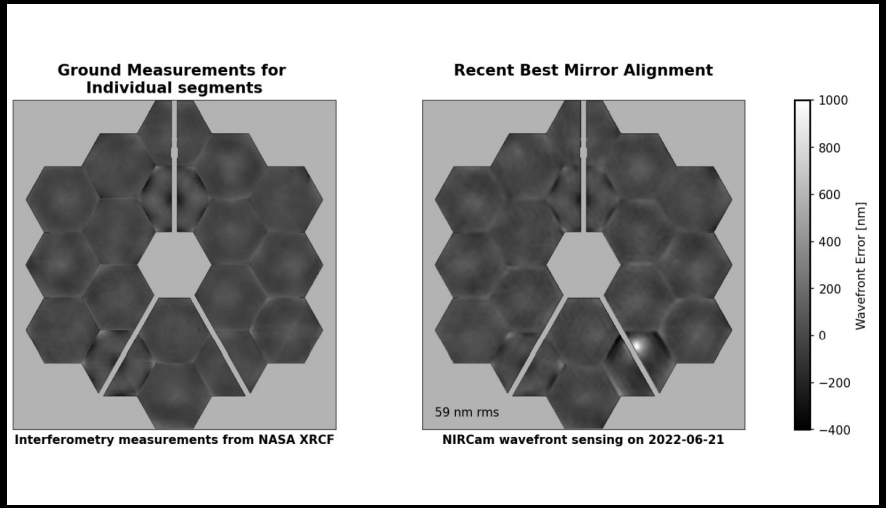
And we've done extra offline testing on these devices.

Mike Menzel
James Webb Space Telescope
Mission systems engineer

The cost of observability



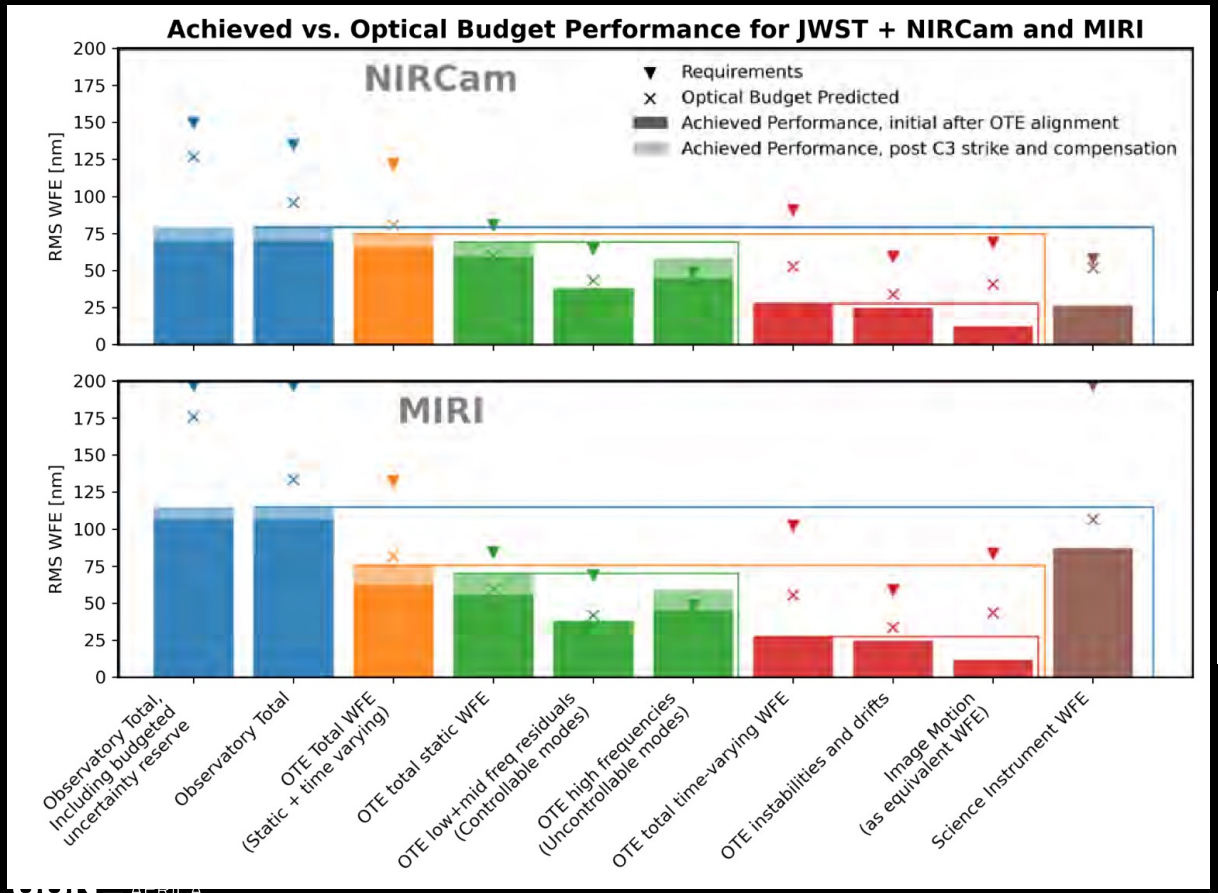
First Reliability Issues

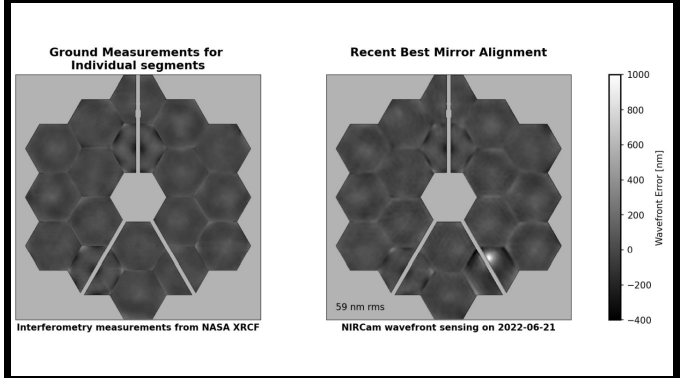


May 22-24 –
Webb hit by large meteoroid

From : Characterization of JWST science performance from commissioning
(https://www.stsci.edu/files/live/sites/www/files/home/jwst/documentation/_documents/jwst-science-performance-report.pdf)

First Reliability Issues

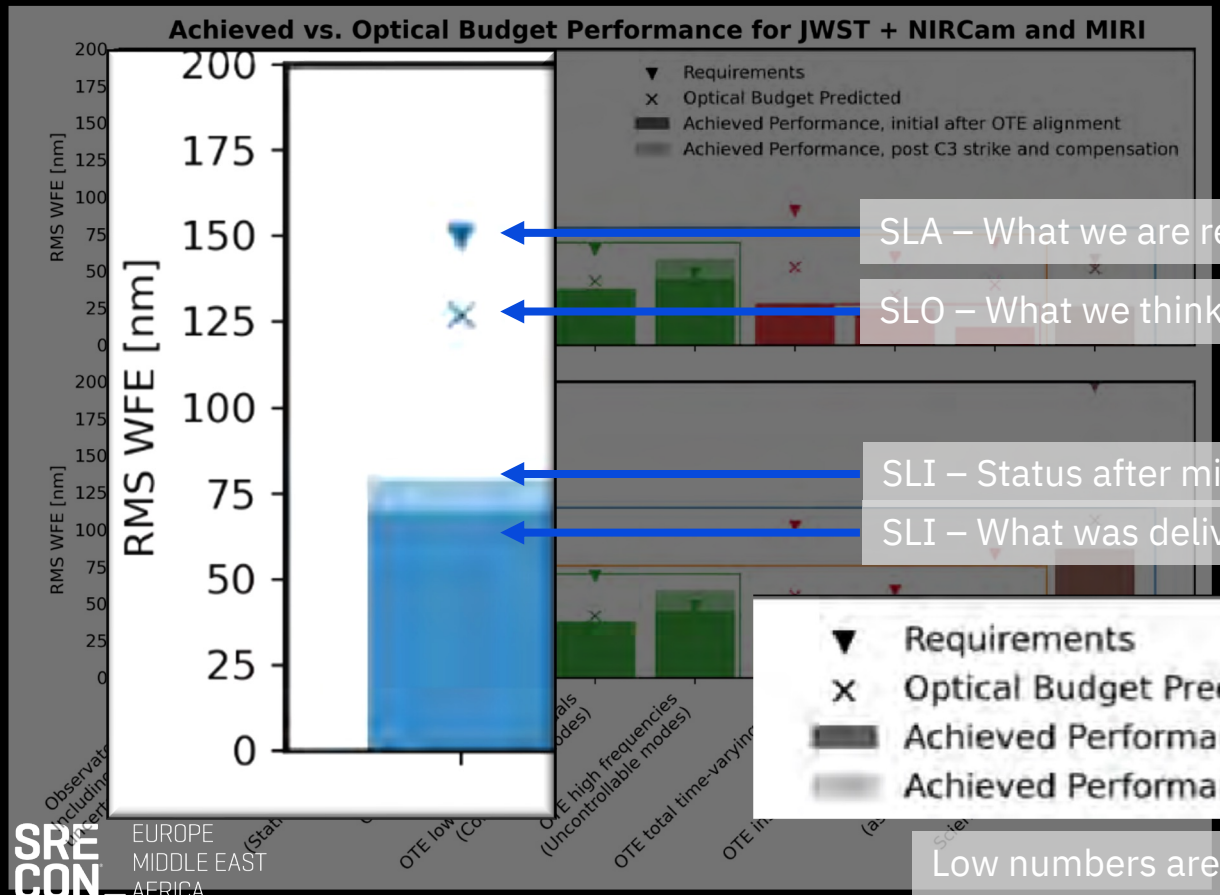




May 22-24 –
Webb hit by meteroid

@flyingbarron

First Reliability Issues – within SLO



SLA – What we are required to deliver

SLO – What we think we can deliver

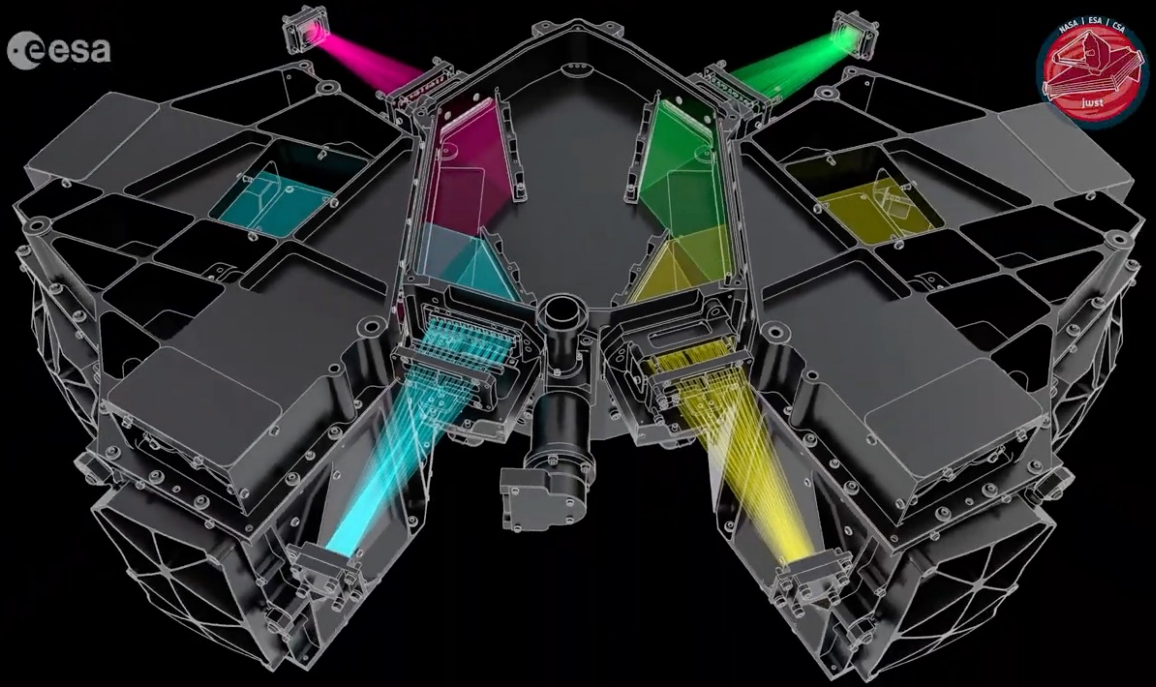
SLI – Status after micrometeroid impact

SLI – What was delivered

Requirements
Optical Budget Predicted
Achieved Performance, initial after OTE alignment
Achieved Performance, post C3 strike and compensation

Low numbers are good

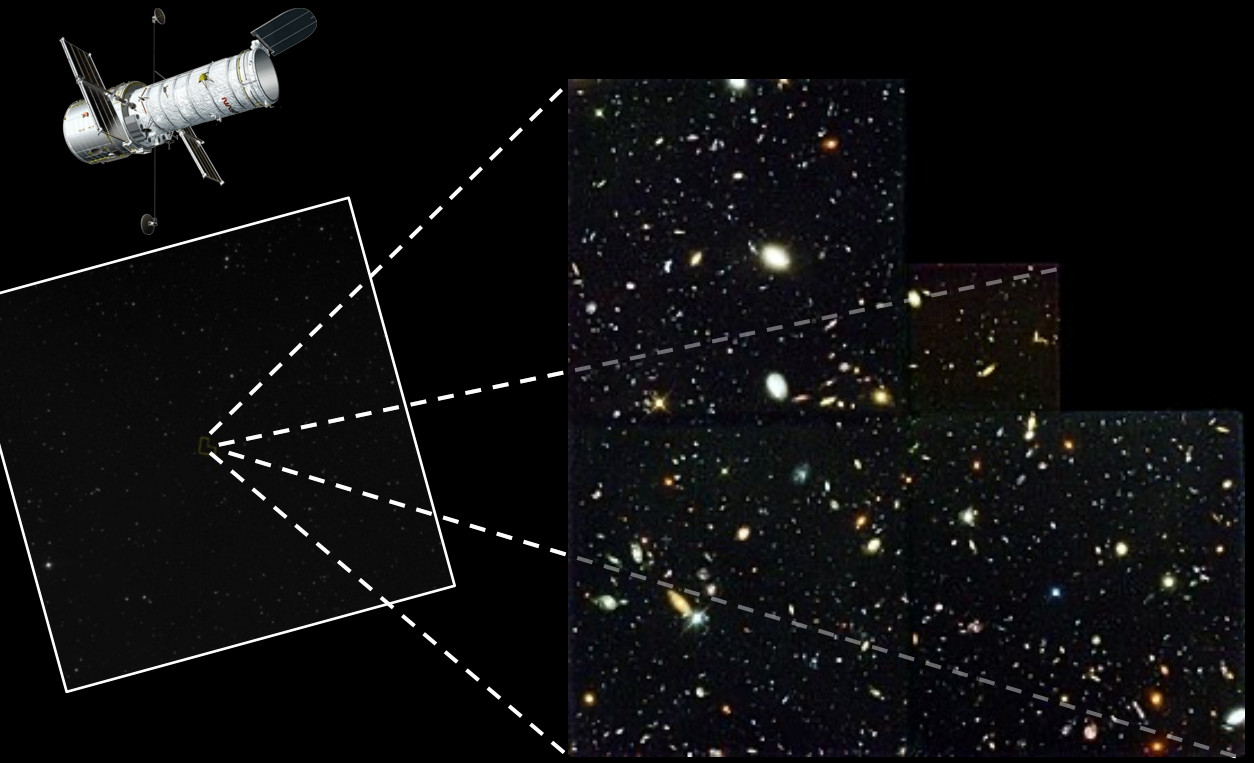
First Reliability Issues



Video by
ESA/ATG medialab

September – High friction in the Mid-Infrared Instrument (MIRI) focus wheels

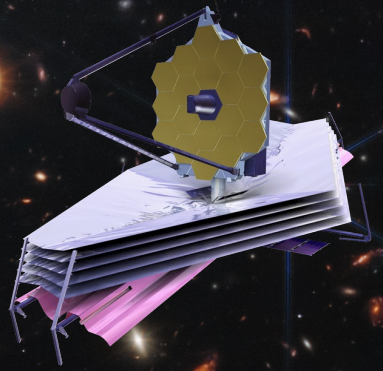
The Hubble Deep Field “Chaos Experiment”



Results:

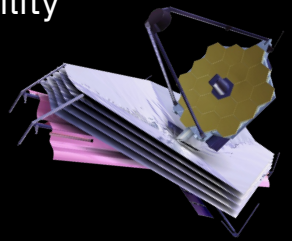
- More galaxies than expected
- Stranger galaxies than expected
- Expand scope - James Webb Space Telescope to perform deep fields

The James Webb Deep Field
“Chaos Experiment”



The Webb ”SRE Strategy”

- Aim for 100% availability/success
- Embrace multiple new technologies for a new product
- Invest all efforts in one major deployment for success
- Maximize functional capability/capacity by reducing monitoring/observability load
- Achieve performance and reliability beyond SLA/SLO



- Create redundant systems, as far as possible
- Reduce technical debt / avoid problems detected in previous missions.
- Prioritize NFRs, balanced with functional requirements. Identify single points of failures
- Balance observability requirements (additional load, complexity, costs) with benefits
- Test, test, test and test some more
  Tests can have business value
- Chaos Engineering as a strategy

SREs shouldn't do it the Webb way

Do not!

- Aim for 100% availability/success
- Embrace multiple new technologies for a new product
- Invest all efforts in one major deployment for success
- Maximize functional capability/capacity by reducing monitoring/observability load
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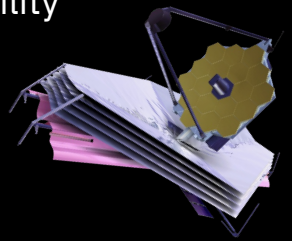

Do!

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The SRE “Webb SRE” Strategy

Redundancy

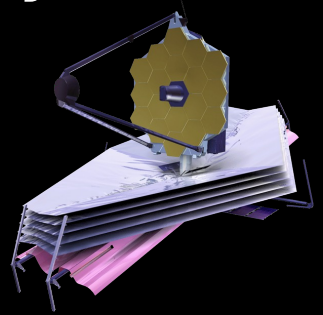
of subsystems/components/microservices/servers
Corollary: Redundancy does not replace reliability

Repairability

of systems and Replaceability of subsystems

Reliability

throughout every service



Thank you – and let's keep in touch!

- **Webb European Space Agency:**
  https://www.esa.int/Science_Exploration/Space_Science/Webb
- **Webb model:**
  https://webb.nasa.gov/content/features/educational/paperModel/paperModel.html
- **IBM SpaceTech:**
  https://www.ibm.com/industries/space
- **IBM CIO Hybrid Cloud Survival Guide**
  https://medium.com/hybrid-cloud-survival-guide

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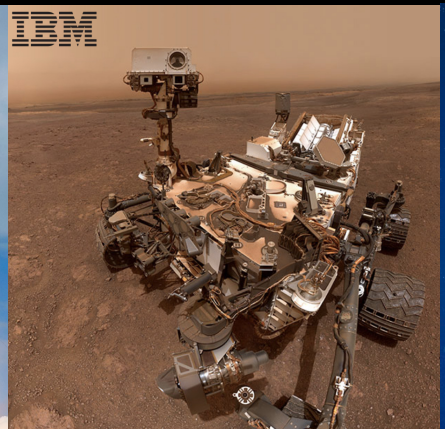
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