Six Principles of Pipeline Design, Taken From The Apollo Missions

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BEAM SUMMIT

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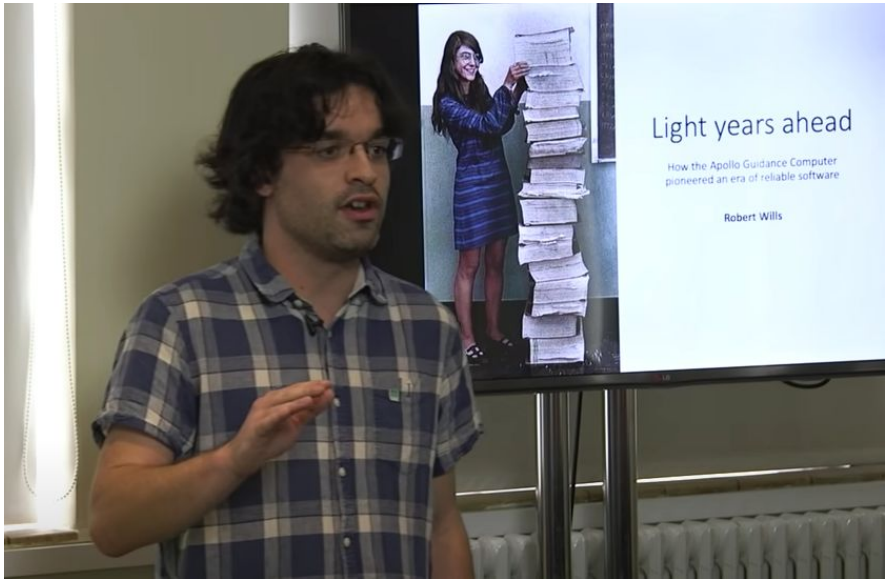
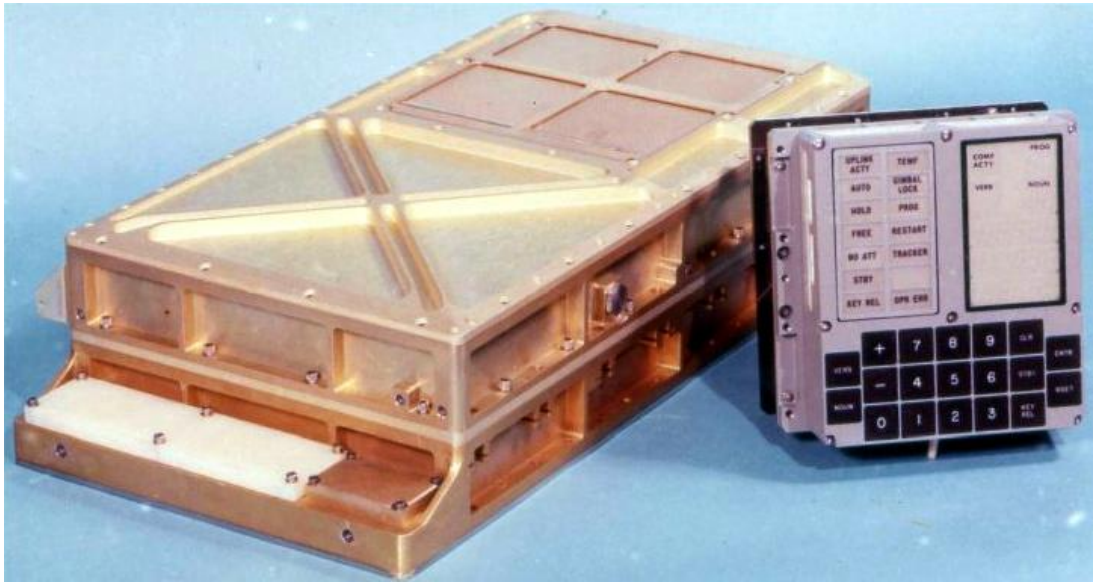
Google Cloud

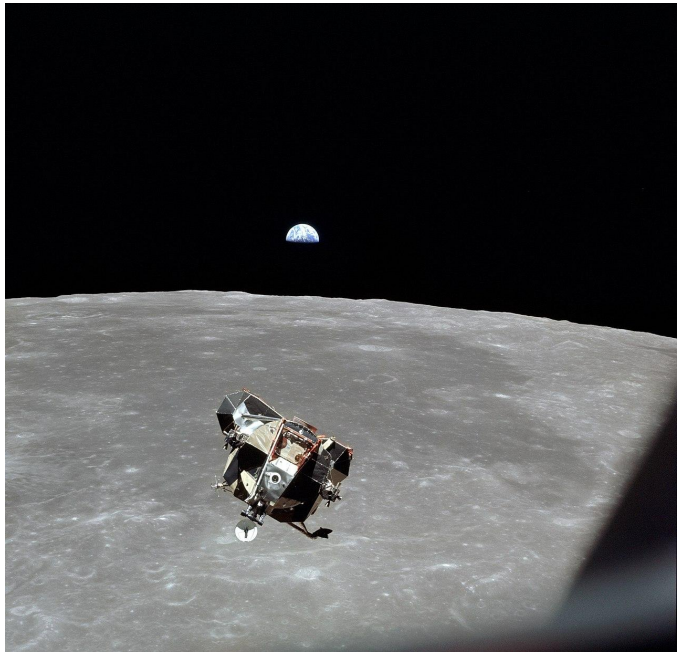
“Light Years Ahead: The 1969 Apollo Guidance Computer” – Robert Wills



youtube.com/watch?v=VYI0Kf_1wqk

An Eventful Journey





Similarities to pipelines in the cloud

Launching a pipeline in the cloud is like launching a spacecraft (...almost)

1. Once launched, control is limited
2. Observability depends on preparation
3. Mistakes can be expensive

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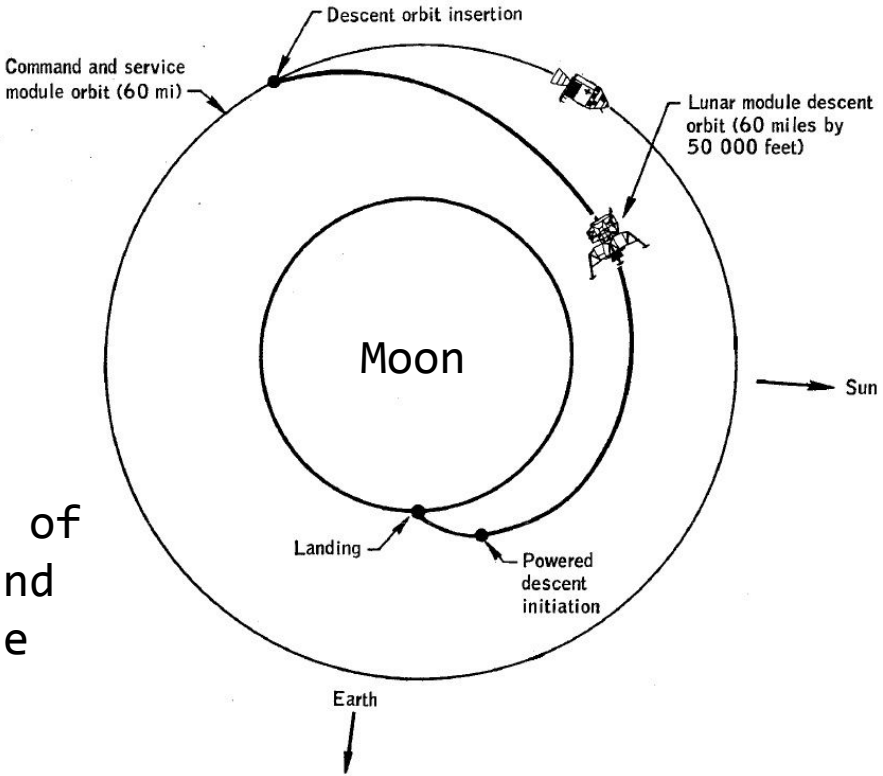
1 Principle: Use a high-level language



Orbit of command module

Image source: Apollo 11 Mission Report, MSC-00171. November 1969, NASA/Manned Spacecraft Center, Houston, TX.

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Principle: Use a high-level language

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Principle: Use a high-level language

Cross-language pipeline support

beam.apache.org/documentation/programming-guide/#multi-language-pipelines

2022.beamsummit.org/sessions/beam-cross-language-transforms/

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Principle: Divide your program into jobs

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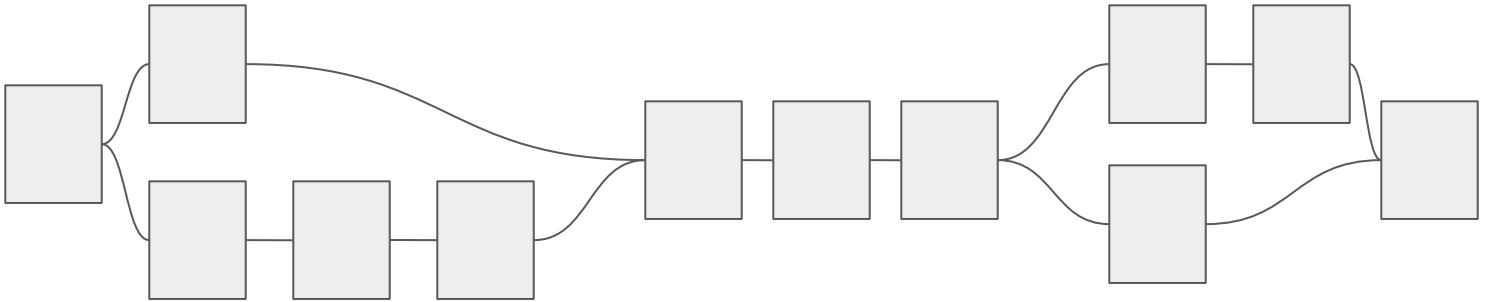
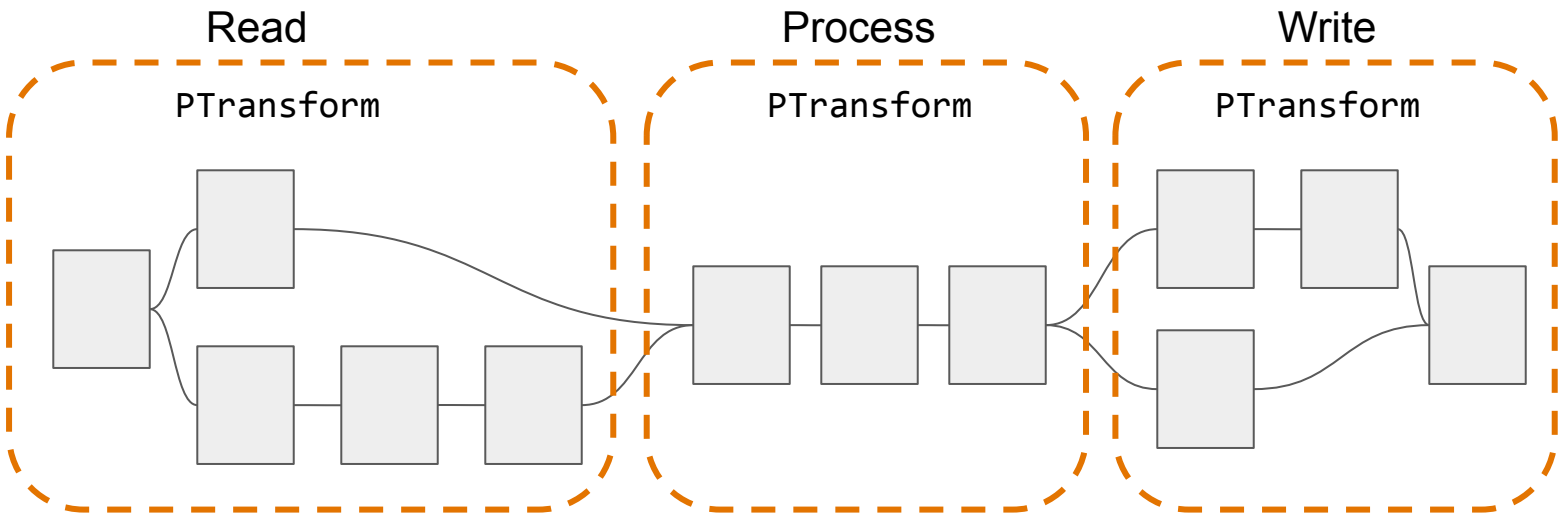
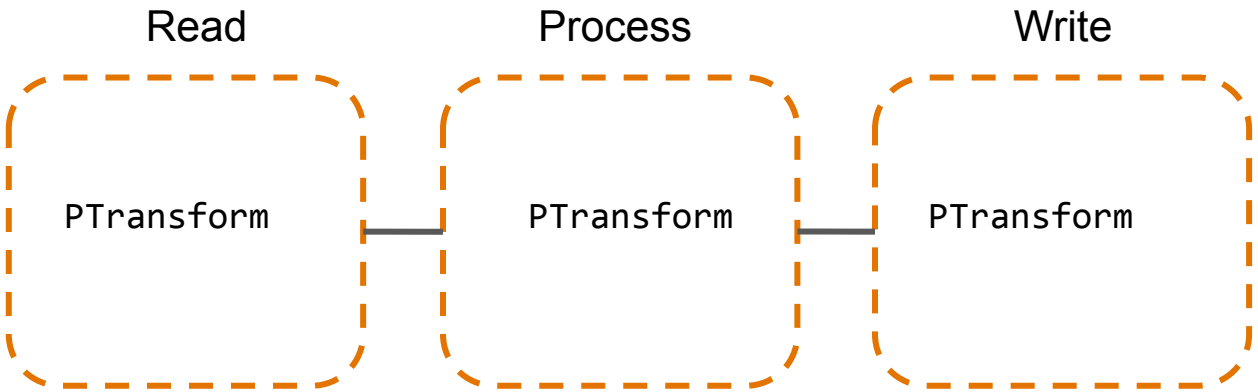


Principle: Divide your program into jobs



Principle: Divide your program into jobs



Write reusable PTransforms, and structure your pipeline as PTransforms

beam.apache.org/contribute/ptransform-style-guide/

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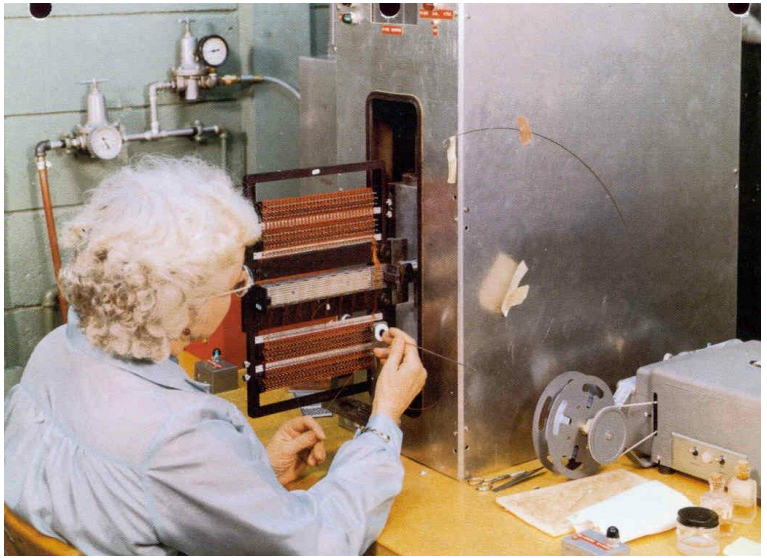
Principle: Restart on failure



Principle: Restart on failure

1. Design jobs for gapless processing
   (error handling, dead letter queue)
2. Considering draining vs. canceling a pipeline*
3. Run a parallel updated pipeline

cloud.google.com/architecture/building-production-ready-data-pipelines-using-dataflow-deploying

2022.beamsummit.org/sessions/error-handling-asgarde/

github.com/tosun-si/asgarde

*runner specific feature

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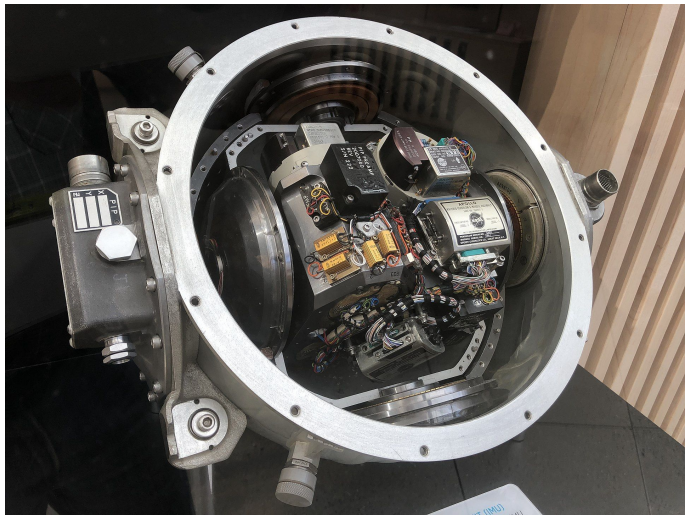
Principle: Checkpoint good state



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Principle: Checkpoint good state

1. Reshuffles trigger a checkpoint and interacts with I/O
2. Behaviour is Runner dependent: Checkpoint in Dataflow and Flink

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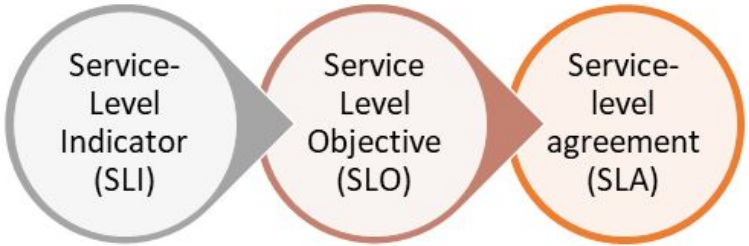
Principle: Hardware monitors software



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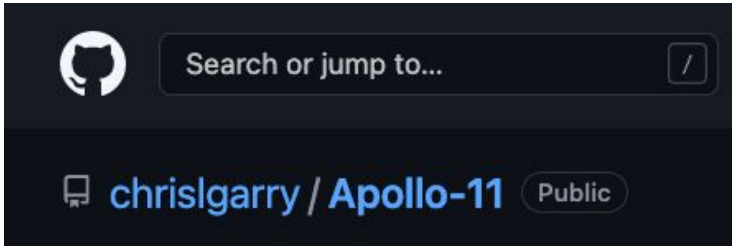
Principle: Hardware monitors software



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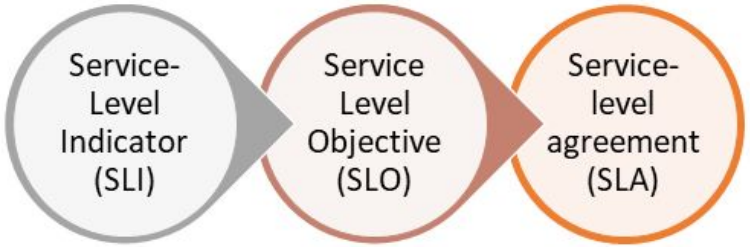
Principle: Hardware monitors software



cloud.google.com/architecture/building-production-ready-data-pipelines-using-dataflow-planning

sre.google/resources/book-update/data-processing-pipelines/

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Principle: Send Telemetry

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Principle: Send Telemetry

Beam Metrics*:

→ `Counter`
→ `Distribution`
→ `Gauge`

- Low-level metrics
- Business-level metrics

*Not all metrics are supported by all runners
beam.apache.org/documentation/runners/capability-matrix/what-is-being-computed/

Conclusions

Recap: The Six Principles

1. High-level language: leverage cross lang pipelines if necessary
2. Divide and conquer: write reusable PTransforms, compose pipelines
3. Restart on failure: write fault tolerant, gapless, resilient pipelines
4. Checkpoint: reshuffle/shuffling to create backtracking barriers
5. Monitor: define SLOs from the planning phase, monitor accordingly
6. Telemetry: produce business level metrics, use them SLOs too

Conclusions

Pipelines and aircrafts are not exactly the same, but both have to land successfully.

Don't hope for the best. Prepare. Hope is not a strategy.

Further reading:

[Building production-ready data pipelines using Dataflow]

[Design your pipeline]
[Create your pipeline]
[Test your pipeline]

[SRE Data Processing Pipelines]

Thank you!