Centre de Calcul
de l'Institut National de Physique Nucléaire
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Running event-driven workflows with dCache storage events

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Concept & Technology

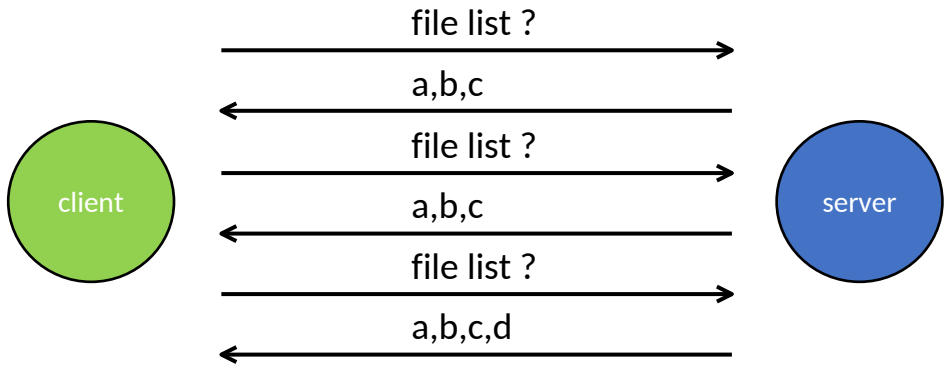
dCache

- a system for storing and retrieving huge amounts of data
- supports many access protocols
- popular with science grid use cases

Kafka

- an event streaming/message queuing platform
- producer/consumer model
- fast, scalable

What is polling, the usual way we detect changes ?



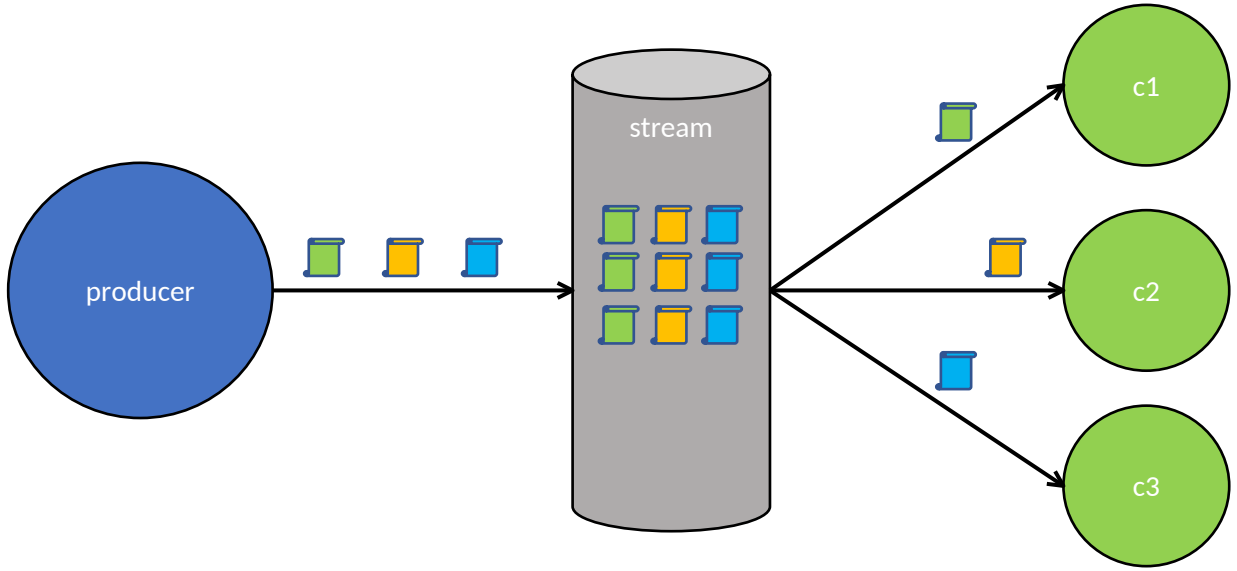
In a traditional polling approach, the client questions the server at regular intervals and reacts to its response.

Concept & Technology

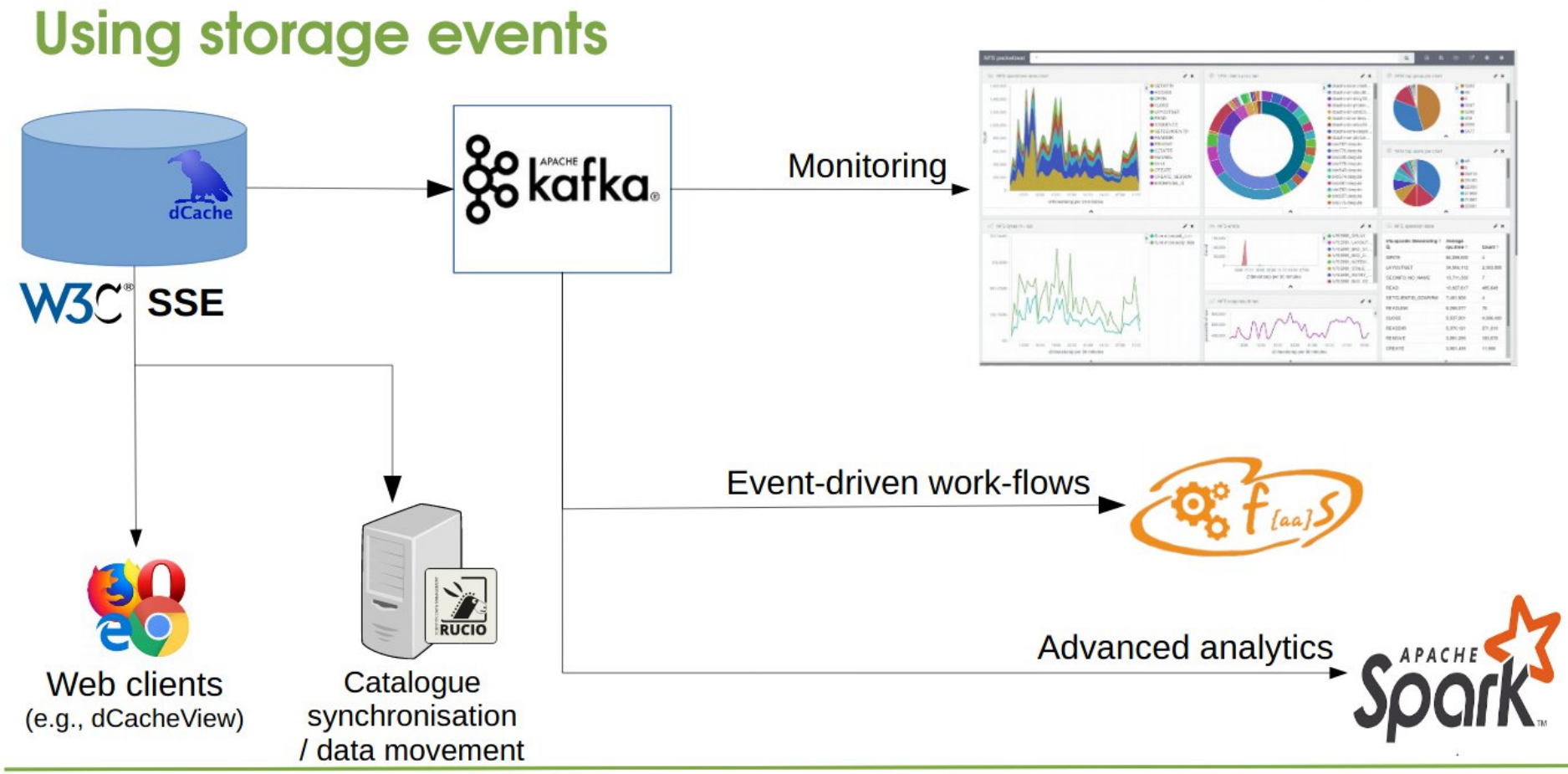
In event-driven architecture, the producer (= server) is the initiator.

Consumer: continuously listens for incoming messages in the stream

Producer: publishes an event in the stream when something happens



Concept & Technology



Proof-of-Concept @ CC-IN2P3

Context: december 2019, a campaign to simulate LSST images in the European grid. Hundreds of terabytes and hundreds of thousands of files will be generated.

Problem 1: that data must then be processed, but our grid storage (dCache) is not available on worker nodes via POSIX for batch processing

Problem 2: the size of the LSST pool in dCache is limited, and we cannot store the complete dataset

Solution: copy incoming data to our GPFS filesystem before processing it

Traditional approach:

- **manually and periodically copy the data from dCache to GPFS**
- **make sure not to copy incomplete files to GPFS (pause and wait for those running to finish ?)**
- **empty the dCache pool to free space for incoming data**

=> requires human intervention at each step

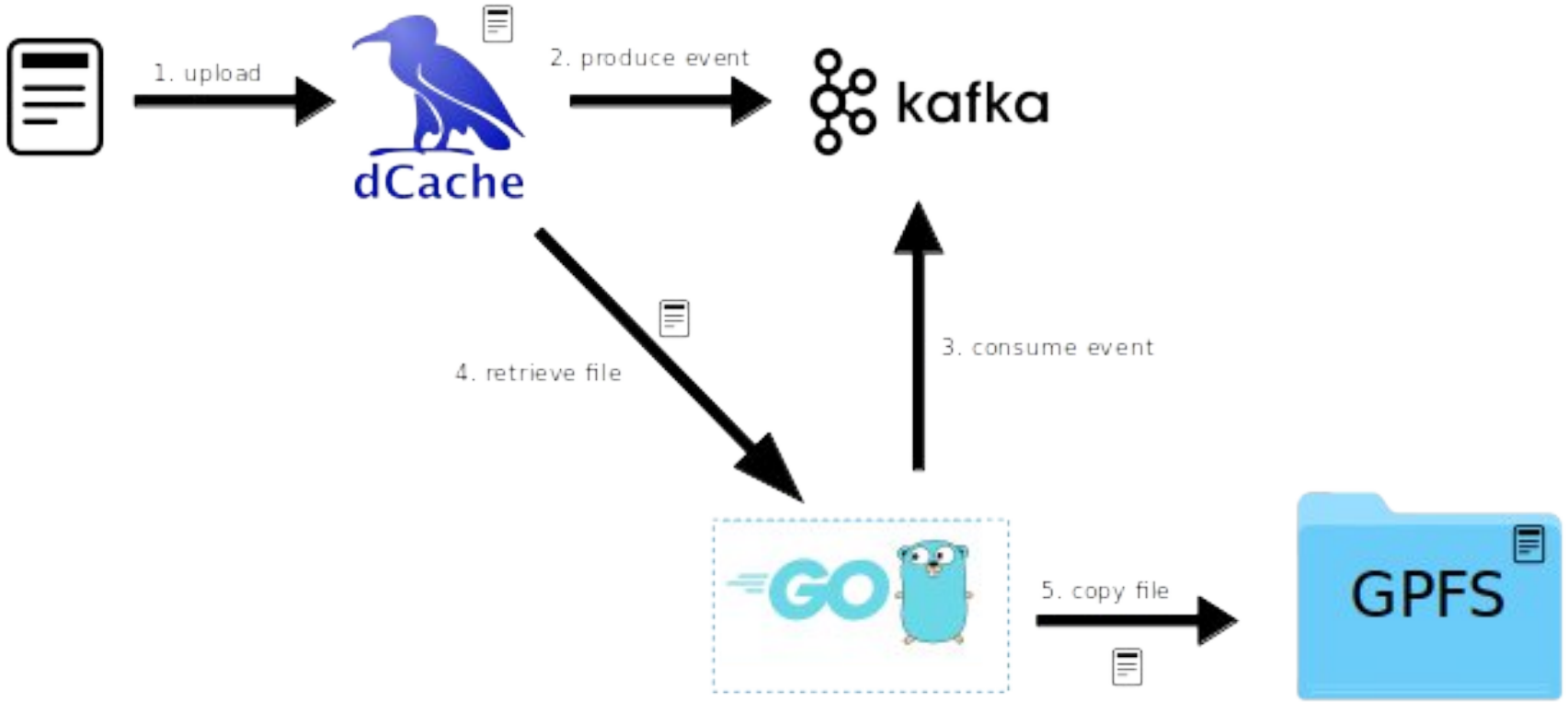
=> difficult to estimate the duration of the bulk copy operation for all files

Proof-of-Concept @ CC-IN2P3

Event-driven approach:

- automatically copy files to GPFS as soon as they are uploaded to dCache
- short, atomic copy operations, happening file by file

=> does not require human attendance



Proof-of-Concept @ CC-IN2P3

Implementation details:

- written in Go, source code available: https://gitlab.in2p3.fr/bastien.gounon/dcalqr
- runs as a daemon, from a single binary executable
- simple toml configuration file
- x509 proxy authentication
- automatic retry
- checksum validation
- metrics logging (throughput, file size)
- configurable number of maximum parallel transfers
- consumer groups (group offset tracking + built-in scalability)

Proof-of-Concept @ CC-IN2P3

```
[kafka]
topic = "billing"
servers = [ "10.0.0.10:9092", "10.0.0.11:9092", "10.0.0.12:9092",]
consumergroup = "imsimprod001"

[dcache]
url = "https://ccdcacli236.in2p3.fr:2880/lsst"
pool = "/pnfs/in2p3.fr/data/lsst"
folder = "/lsst/user/b/bastien.gounon"
retryseconds = 1
retrytimes = 10
maxdownloads = 10
timeout = 600

[local]
proxy = "/tmp/x509_proxy"
capath = "/etc/grid-security/certificates"
downloadfolder = "/sps/lssttest/datasets/desc/DC2/Run2.2i/sim/input"
permissions = '2750'
failedtasksfile = "failed.csv"
successfultasksfile = "success.csv"
```

Feedback & Limitations

Feedback

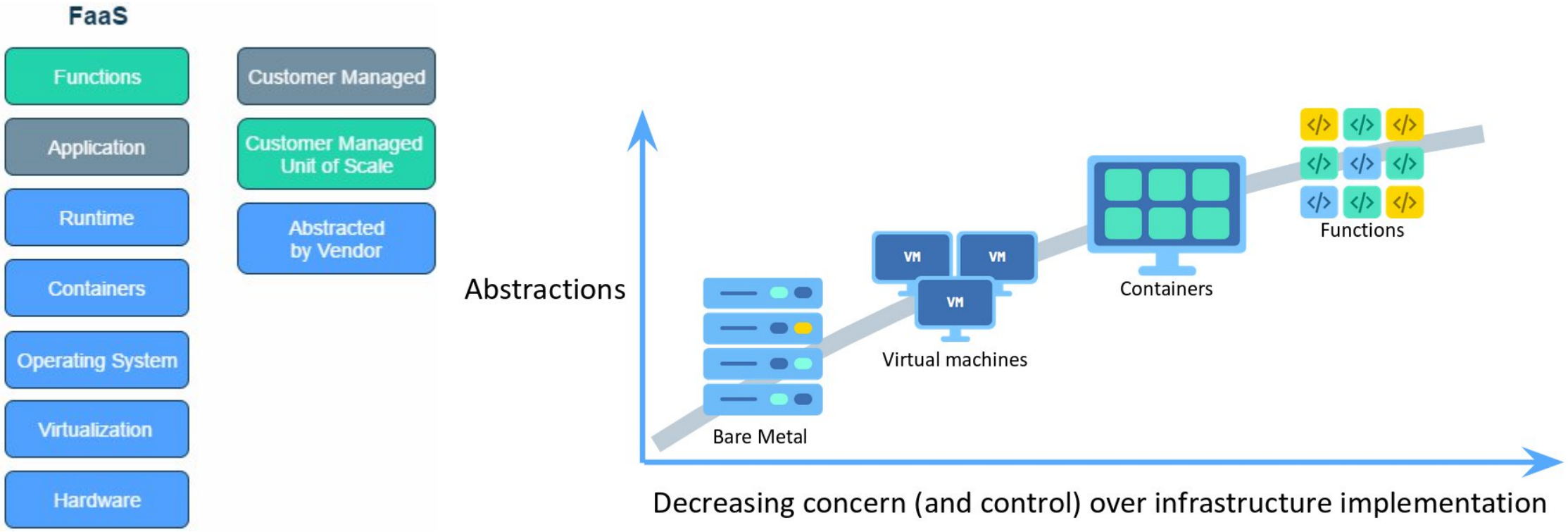
- hours saved in operations instead spent on development effort, but we also built valuable experience working with storage events
- successfully used to copy ~200TB of data and ~1M files over the campaign duration
- dCache and Kafka both demonstrated very good stability and consistency
- failure rate < 1%

Limitations:

- small caveat when using SRM upload to dCache (issue #5285)
- requests would sometimes hang for a few minutes, most likely due to local issues
- consumers scaling not tested since dCache does not support multi-partitions topics

Prospective: event-driven FaaS workflows ?

Function-as-a-Service is a computing model in which simple functions are run in response to triggers (usually events)



Prospective: event-driven FaaS workflows ?

For example, it makes it possible to automatically:

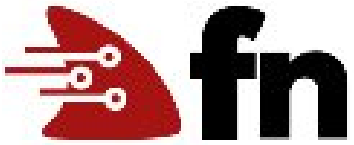
- uncompress and/or copy incoming data

- ingest new files into catalogs

- run batch jobs or data processing pipelines

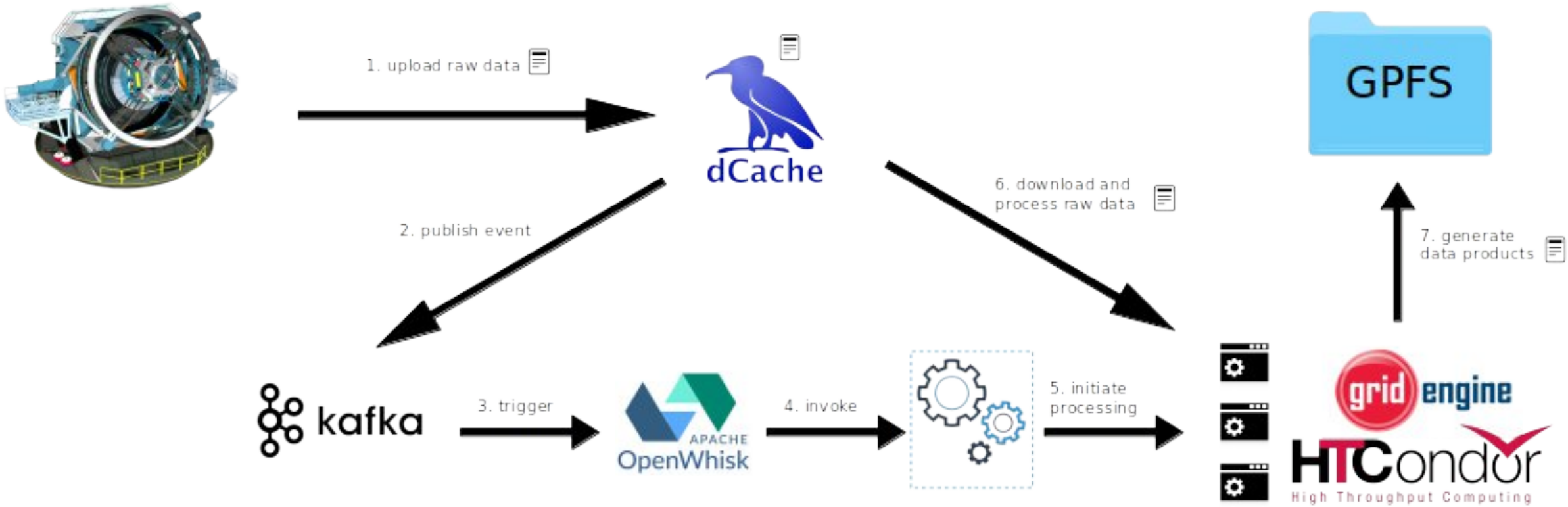
...

Many FaaS platforms are already available, in and out of the cloud:



Prospective: event-driven FaaS workflows ?

Illustration of what a fully-automated data processing pipeline may look like:



Thank you!

Questions?

Backup Slides

contents of a dCache storage event in Kafka:


```
{
   "date":"2019-07-09T11:11:57.024+02:00",
   "owner":"/O=GRID-FR/C=FR/O=CNRS/OU=CC-IN2P3/CN=Adrien
Georget",
   "msgType":"request",
   "clientChain":"134.158.240.106",
   "mappedGID":239,
   "cellName":"WebDAV-ccdcalitest12",
   "session":"door:WebDAV-ccdcalitest12@webdav-
ccdcalitest12Domain:AAWNO/PLJUg:1562663516332000",
   "subject":[
      "UserNamePrincipal[ageorget]",
      "UidPrincipal[3915]",
      "LoAPrincipal[IGTF-AP:Classic]",
      "EntityDefinitionPrincipal[Person]",
      "FQANPrincipal[/dteam/NGI_FRANCE/sites/IN2P3-CC]",
      "GidPrincipal[239,primary]",
      "/O=GRID-FR/C=FR/O=CNRS/OU=CC-IN2P3/CN=Adrien Georget",
      "FQANPrincipal[/dteam/NGI_FRANCE]",
      "FQANPrincipal[/dteam/NGI_FRANCE/sites]",
      "GroupNamePrincipal[lcgdteam,primary]",
      "Origin[134.158.240.106]",
      "EmailAddressPrincipal[adrien.georget@cc.in2p3.fr]",
      "FQANPrincipal[/dteam,primary]"
   ],
   "transferPath":"/pnfs/in2p3.fr/data/doma/testWebdav",
   "sessionDuration":692,
   "storageInfo":"disk:doma@osm",
   "cellType":"door",
   "fileSize":119936222,
   "mappedUID":3915,
   "VERSION":"1.0",
   "queuingTime":0,
   "cellDomain":"webdav-ccdcalitest12Domain",
   "client":"134.158.240.106",
   "pnfsid":"00004F0AF7BEAE5A4CBEBF0FBF036D01F4C4",
   "billingPath":"/pnfs/in2p3.fr/data/doma/testWebdav",
   "status":{
      "msg":"",
      "code":0
   }
}
```

Backup Slides

dcalqr logs excerpt:

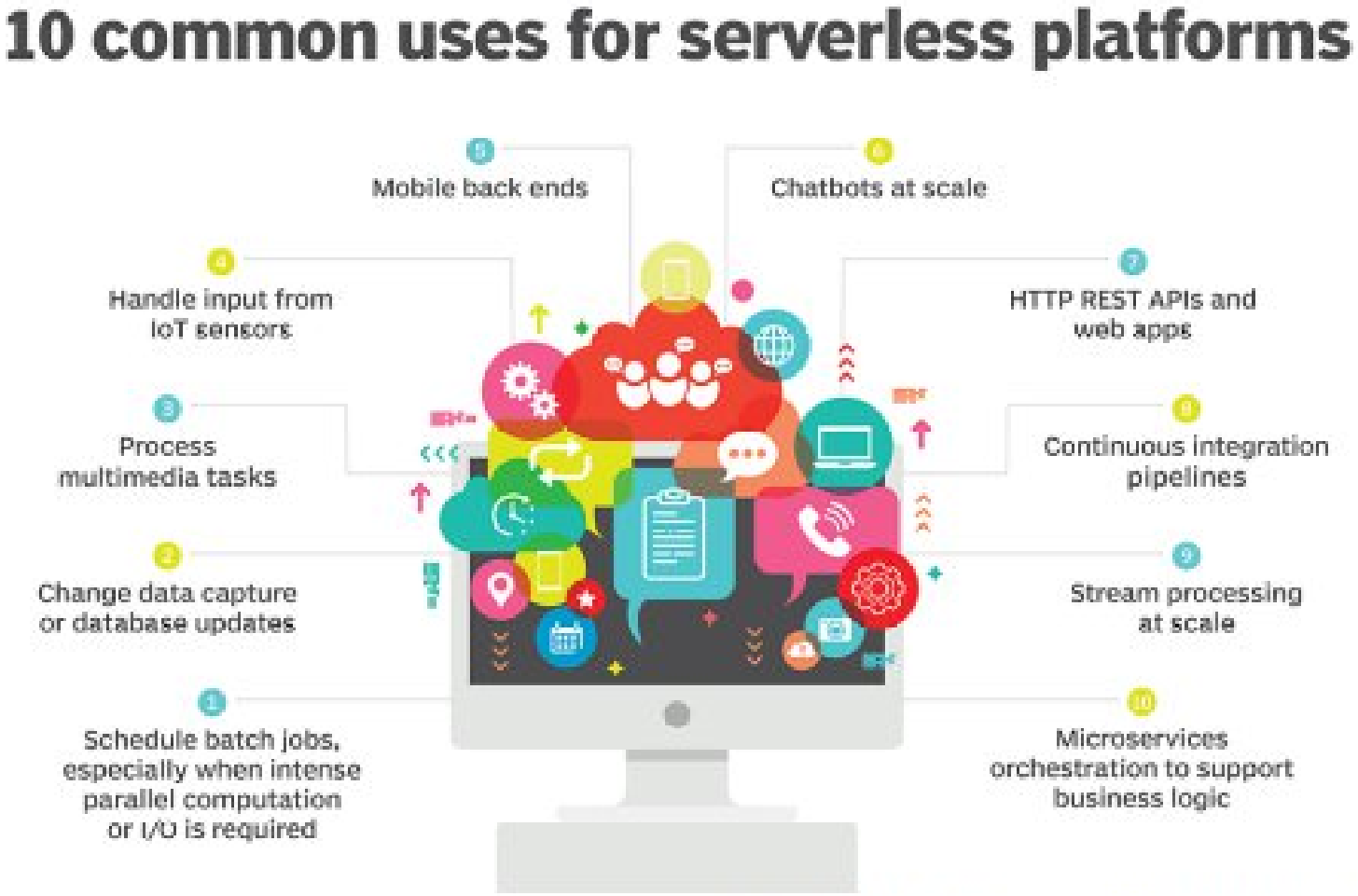
```
2020/01/23 17:47:14 [UPLOAD] New file on partition 0 : /pnfs/in2p3.fr/data/lsst/lsst/user/j/james.perry/23003/2300369
1/fits_01188251_10.tar (f9c82897-0976-ed88-61d8-0db305308527)
2020/01/23 17:47:14 [CURRENTLY_RUNNING] 1 running tasks: [f9c82897-0976-ed88-61d8-0db305308527] (SYSTEM)
2020/01/23 17:47:15 [COPY_INIT] Creating destination file /sps/lssttest/datasets/desc/DC2/Run2.2i/sim/input/23003/230
03691/fits_01188251_10.tar.part (f9c82897-0976-ed88-61d8-0db305308527)
2020/01/23 17:47:15 [COPY_START] Getting data from https://ccdcacli236.in2p3.fr:2880/lsst/lsst/user/j/james.perry/230
03/23003691/fits_01188251_10.tar (f9c82897-0976-ed88-61d8-0db305308527)
2020/01/23 17:47:15 [COPY_RUN] Copying data to /sps/lssttest/datasets/desc/DC2/Run2.2i/sim/input/23003/23003691/fits_
01188251_10.tar.part (f9c82897-0976-ed88-61d8-0db305308527)
2020/01/23 17:47:16 [COPY_OVER] https://ccdcacli236.in2p3.fr:2880/lsst/lsst/user/j/james.perry/23003/23003691/fits_01
188251_10.tar to /sps/lssttest/datasets/desc/DC2/Run2.2i/sim/input/23003/23003691/fits_01188251_10.tar (checksum vali
dation: OK) (f9c82897-0976-ed88-61d8-0db305308527)
2020/01/23 17:47:16 [COPY_REPORT] 217 MB copied in 379.387386ms, 4355.91 Mbps (f9c82897-0976-ed88-61d8-0db305308527)
```

Backup Slides

Pros for function-as-a-service architecture:

- **Developer-friendly**
- **Focus on features**
- **Isolation**
- **Scalability**
- **Pay-per-use / No idle time: “If the events don’t happen, the workflow is not run and you do not have to pay for servers to host it.”**
- **Zero infrastructure management (in the cloud)**
- **Instantaneous deployment and update**

Backup Slides



source: https://searchitoperations.techtarget.com/definition/serverless-computing