# Mechanisms and Architectures for Tail-Tolerant System Operations in Cloud

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## Outline

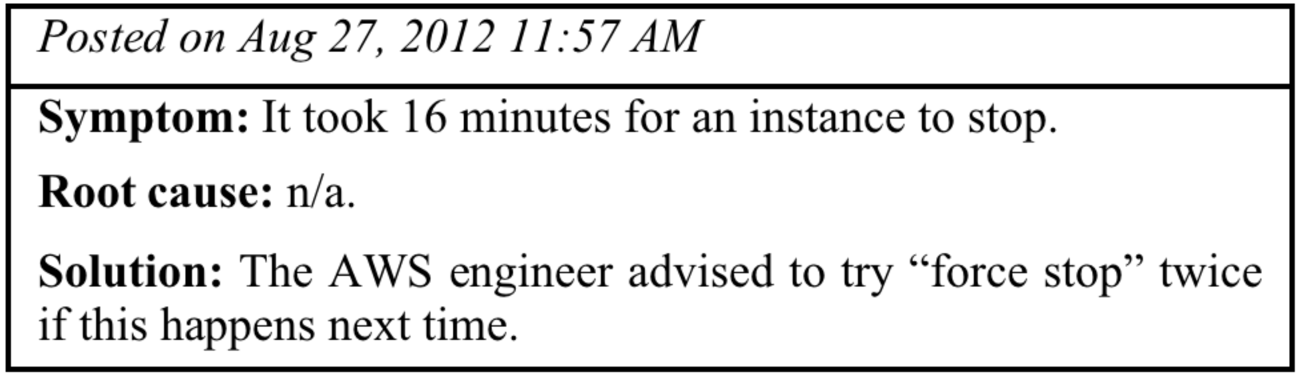
- Motivation
- Tail-Tolerant Mechanisms and API Wrapper
- Deployment Architecture Tactics
- Evaluation
- Conclusion

## Motivation

- System operations (such as upgrade, deployment and backup) in cloud are performed through cloud APIs provided by cloud providers
  - The completion time and reliability of operation tasks depends on the reliability and performance of API calls
- We observed cloud API issues during the development of our commercial product Yuruware Bolt
  - Yuruware Bolt relies EC2 to perform disaster recovery operations
  - e.g., when we detach/attach a volume, it is stuck at detaching/attaching

## Motivation

- We performed searches on EC2 forum
  - 5 API calls: launch instance, start instance, stop instance, attach volume, detach volume
  - extracted API related issues: 922 cases out of 1109 API related cases are API failures
  - 81% of 922 failures are timing failures (stuck API calls and slow responded API calls)



*Posted on Aug 27, 2012 11:57 AM*

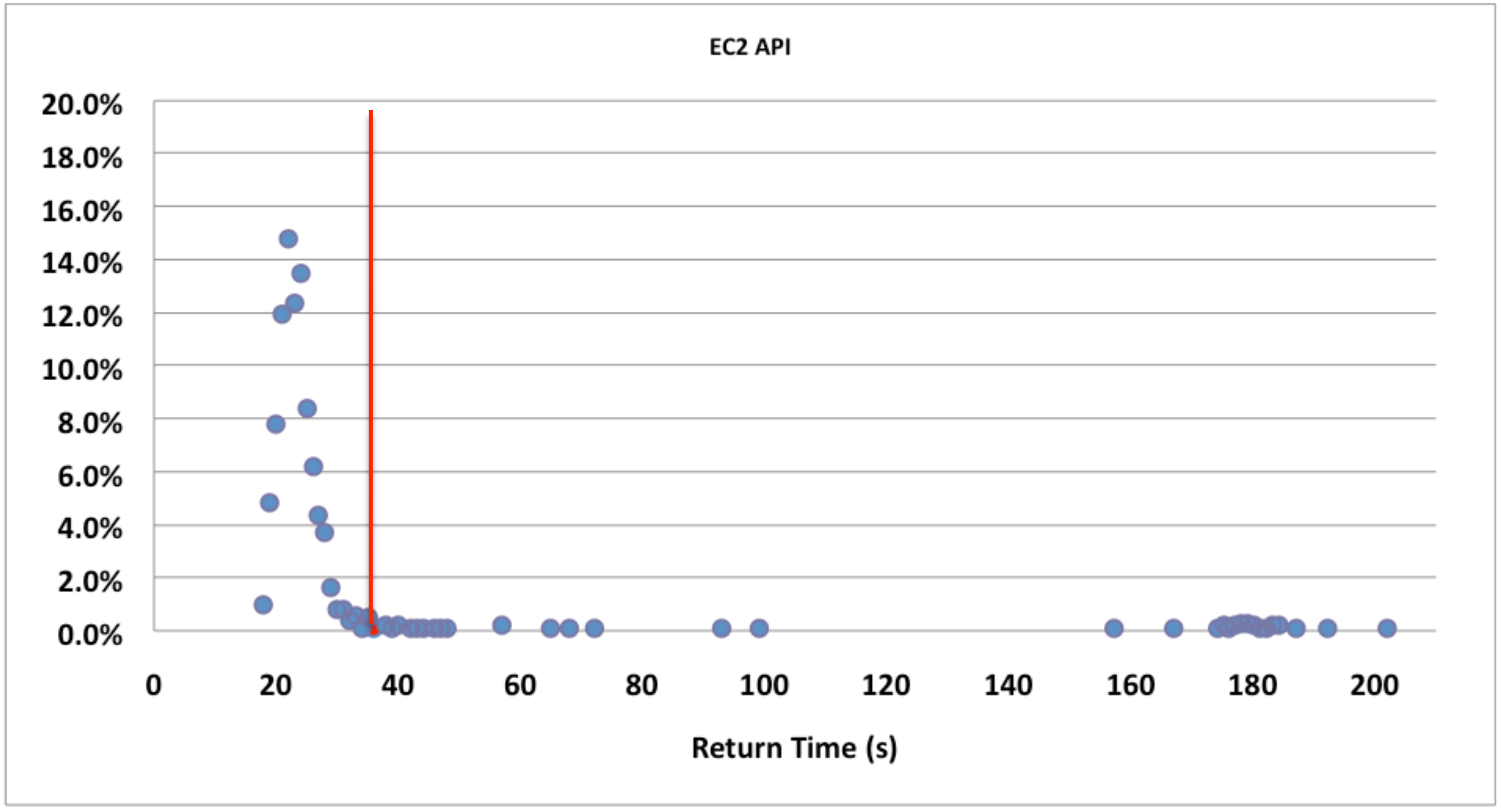
**Symptom:** It took 16 minutes for an instance to stop.

**Root cause:** n/a.

**Solution:** The AWS engineer advised to try "force stop" twice if this happens next time.

## Motivation

- We conducted experiments on the timing behaviour of 5 EC2 API calls and observed that around 4.5% have long tail characteristics

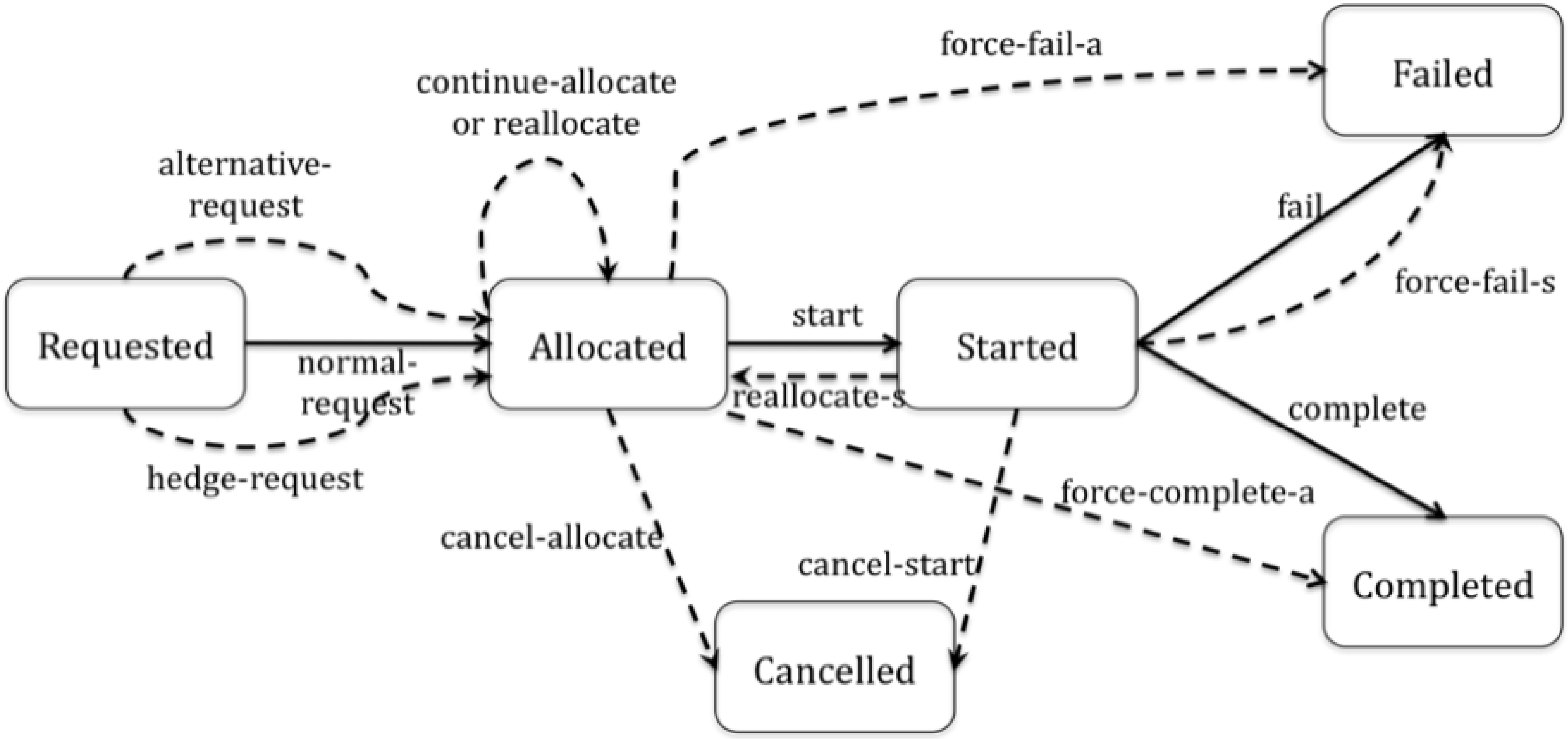


Measurement results of EC2 "launch instance"

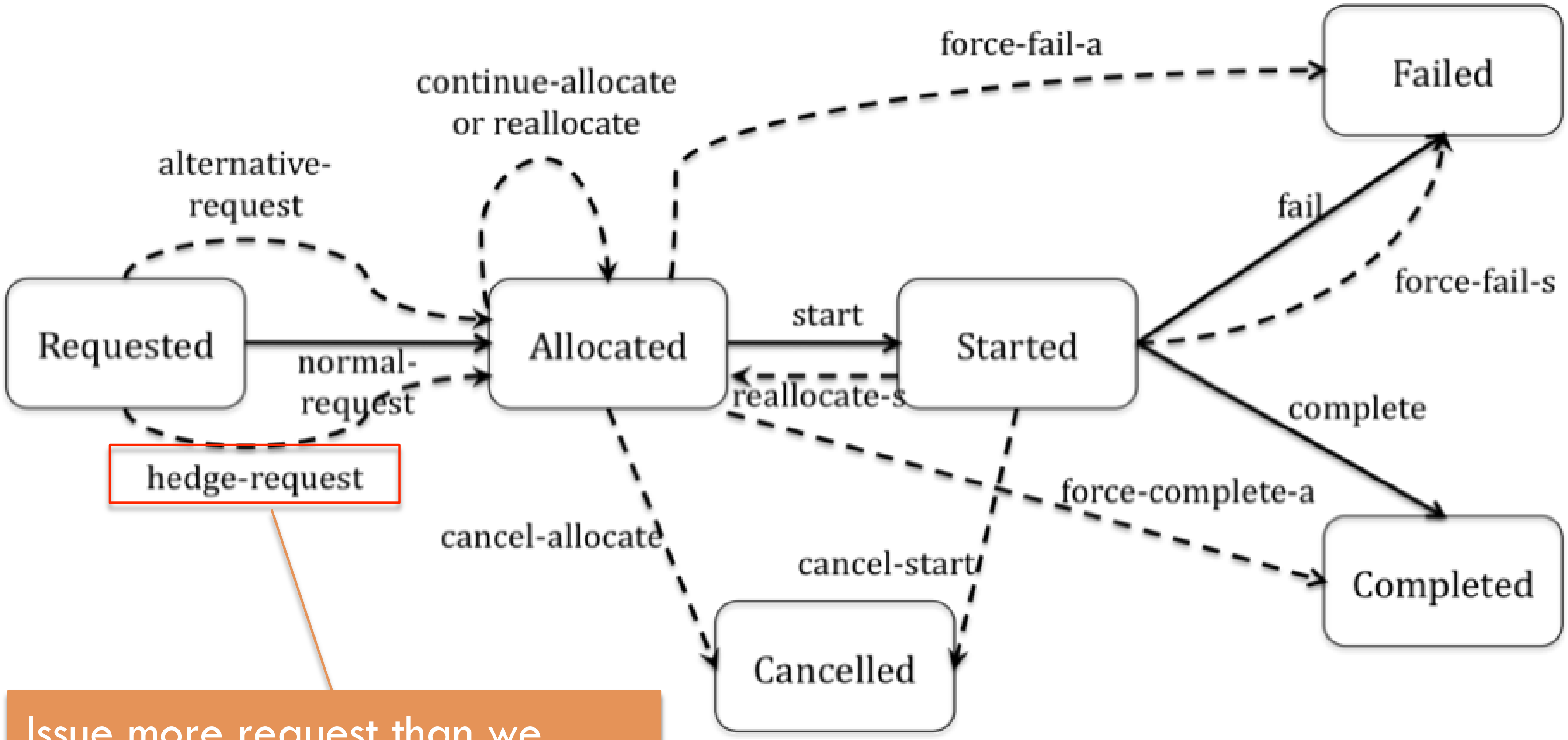
## Motivation

- Cloud API timing failures： major causes of the long-tail of operation tasks
  - Existing research focuses on reducing errors and repair time
- One step of an operation: parallel or deep hierarchical
  - One slow API response will cause the initial operation to be slow to respond

# Tail-Tolerant Mechanisms

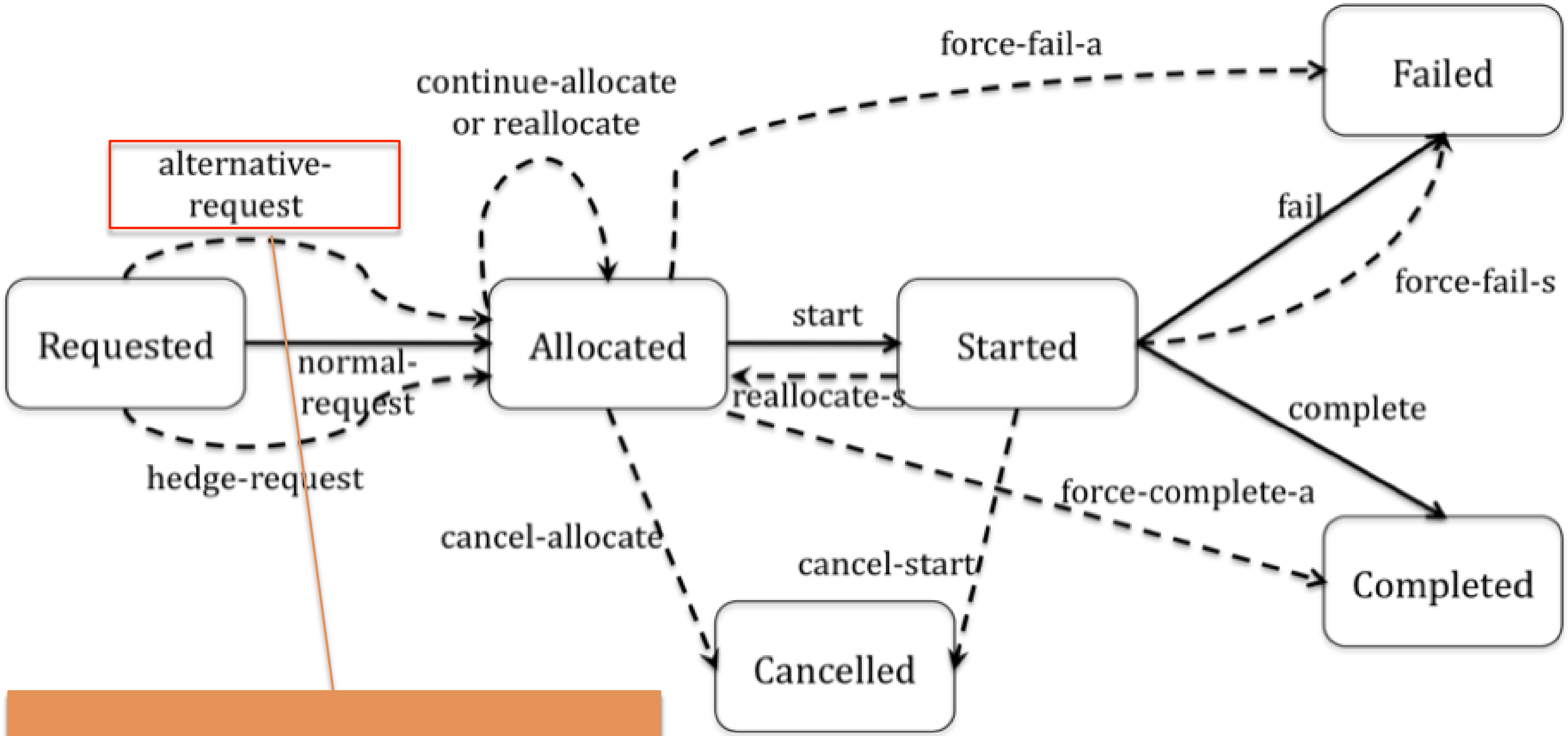


# Tail-Tolerant Mechanisms



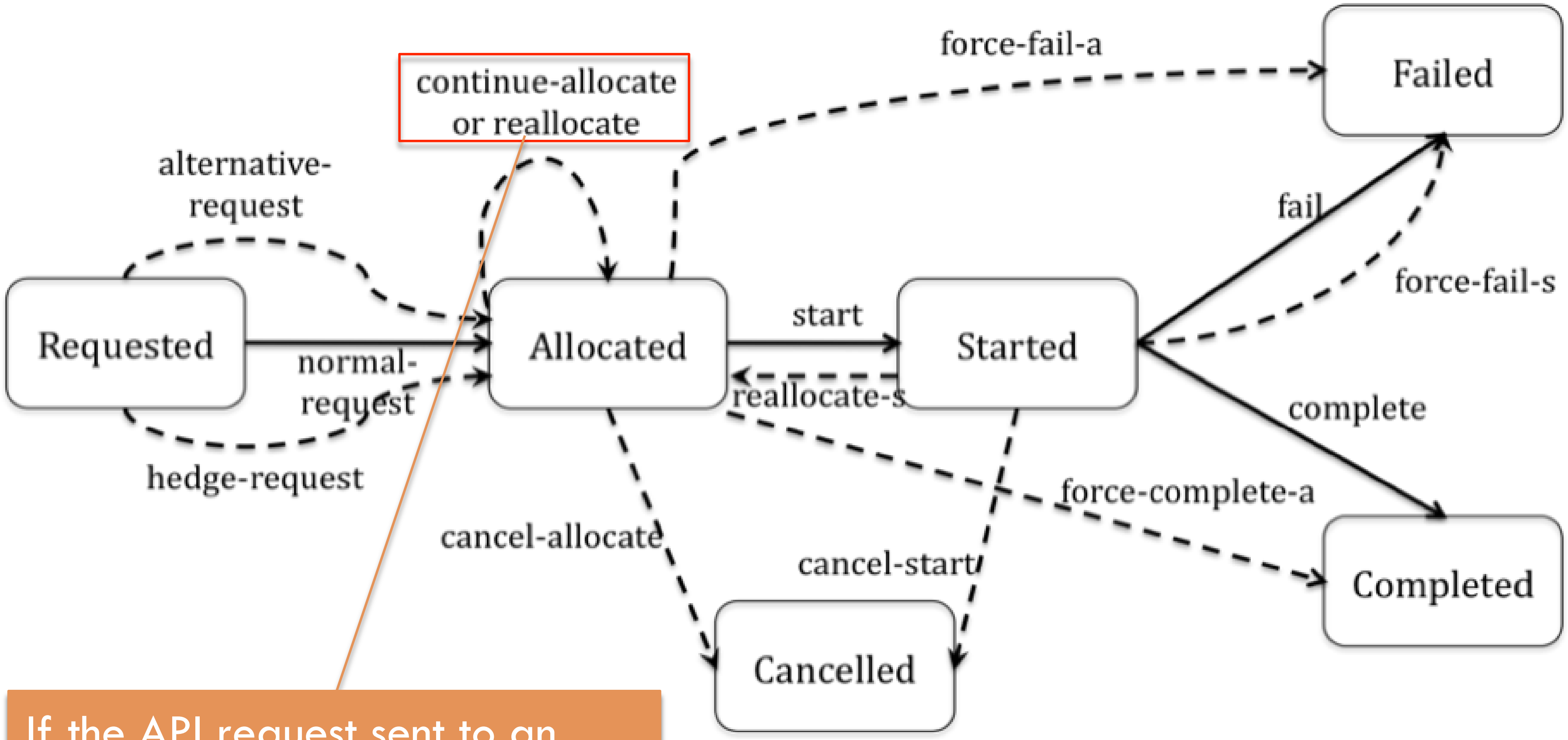
Issue more request than we need and then cancel the remaining immediately after the required number is reached

# Tail-Tolerant Mechanisms



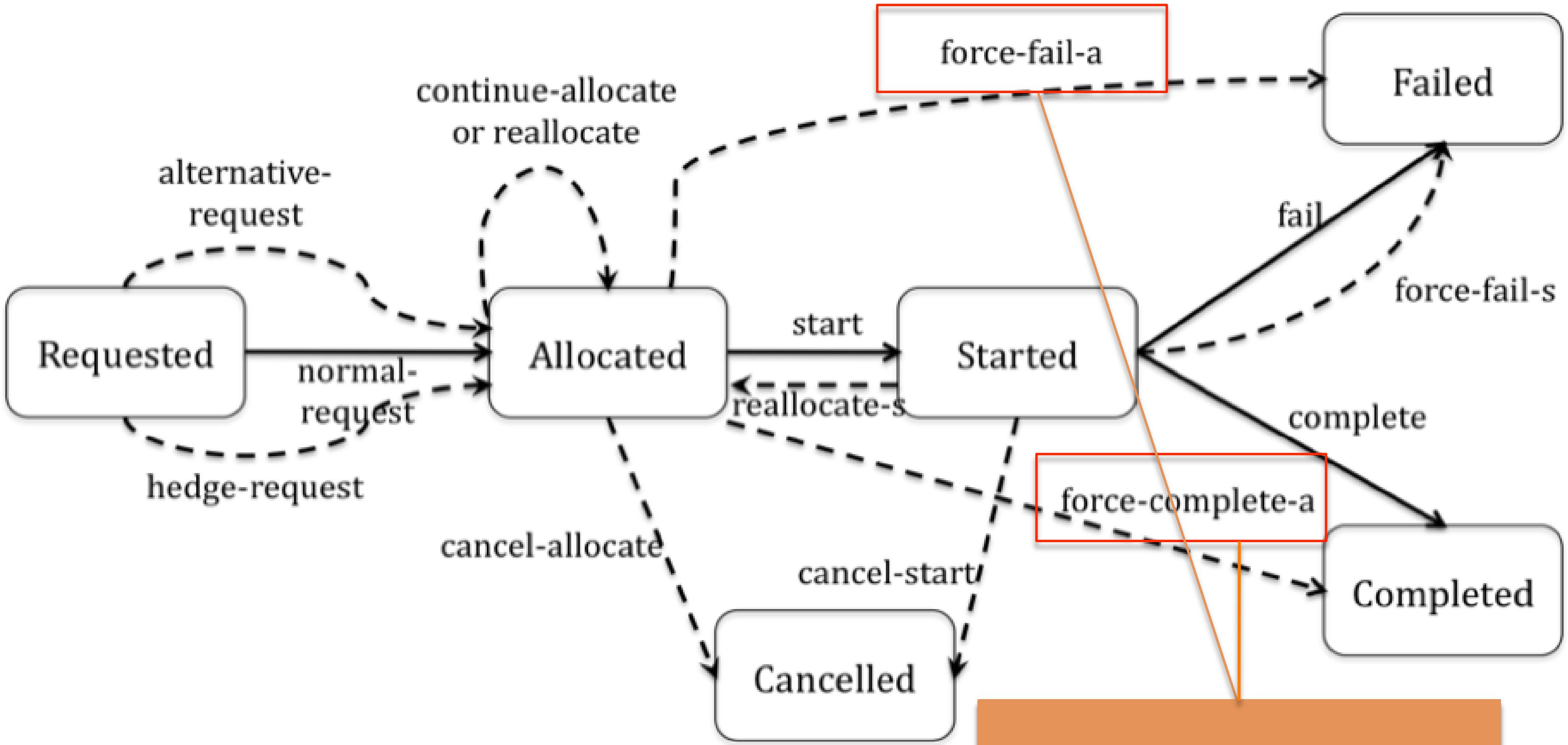
An alternative API is requested at the same time as the original API is requested

# Tail-Tolerant Mechanisms



If the API request sent to an instance is failed or there is no response from the cloud infrastructure

# Tail-Tolerant Mechanisms



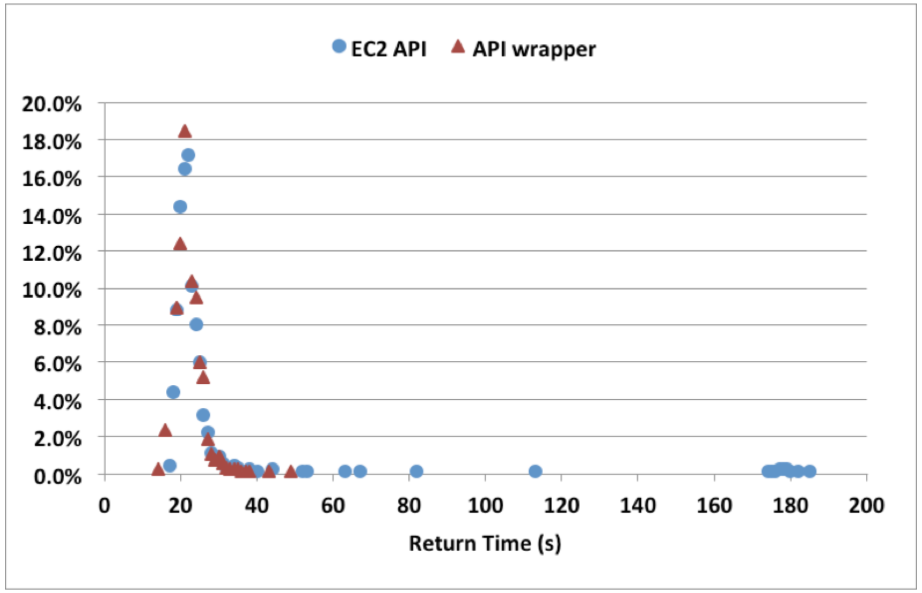
When an API call has been retried for several times and continue to fail

## API Wrapper

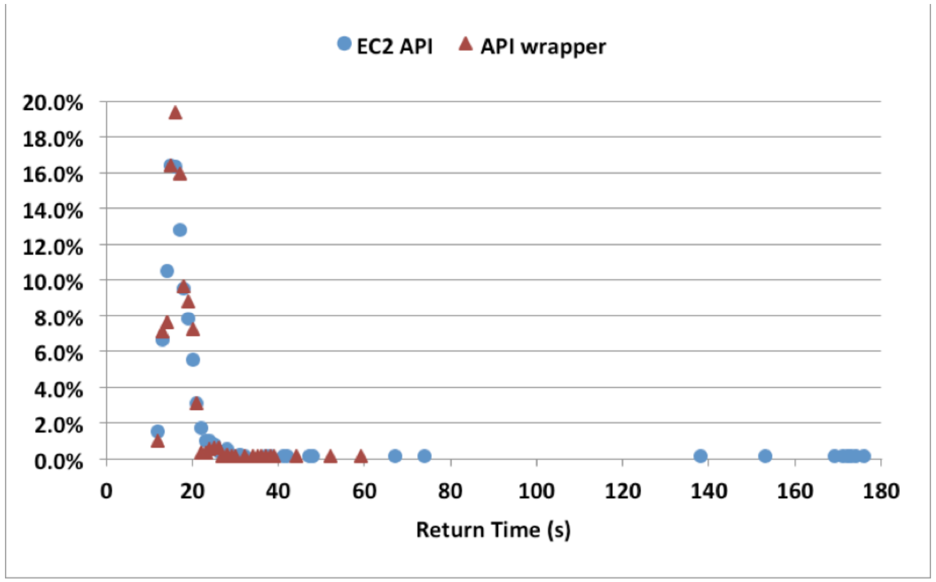
| **API wrapper** | **Pattern** | **Implementation details** |
|---|---|---|
| *launch-instance* | *hedge-request; continue-allocate* | The API wrapper launches two instances when it receives a request. If one instance is launched within the time specified in the timing profile of launch-instance, the API wrapper will kill the other one. If neither of them launches, then the API wrapper re-launches another two instances. |
| *start-instance* | *alternative-request* | The API wrapper starts an instance and launches a new instance using the same image simultaneously, and cancels the one with longer return time. |
| *stop-instance* | *force-complete-a* | The API wrapper launches a call to the stop-instance API, waits for the time specified in the timing profile of stop-instance. If the call is not completed, the API wrapper forces the instance to stop using "force-stop" API. |
| *attach-volume* | *alternative-request* | The API wrapper attaches volume to an instance and launches a new instance at the same time. The wrapper waits for the time specified in the timing profile of attach-volume. If the call is not completed, it re-attaches the volume to the newly launched instance. |
| *detach-volume* | *force-complete-a* | The API wrapper waits for the time specified in the time profile of detach-volume. If not completed, then the API wrapper force-detaches the volume. |

# Evaluation of API Wrapper

- Evaluate API wrapper on EC2
- For each API we wrapped, we measure the return time 1000 times respectively



**Measurement results of "start instance".**



**Measurement results of "stop instance".**

## Deployment Architecture Tactics

- Immutable server
  - Operators make an image which contains a new version of everything an application needs. After the image is launched, nothing more is added or allowed to be changed.
- Micro service
  - Operators break down an application into micro-services and make each service run on different VMs.
  - Lightweight instances and less performance interference
- Redundancy:
  - Operator can run more than the required number of VMs to avoid long-tail operations.

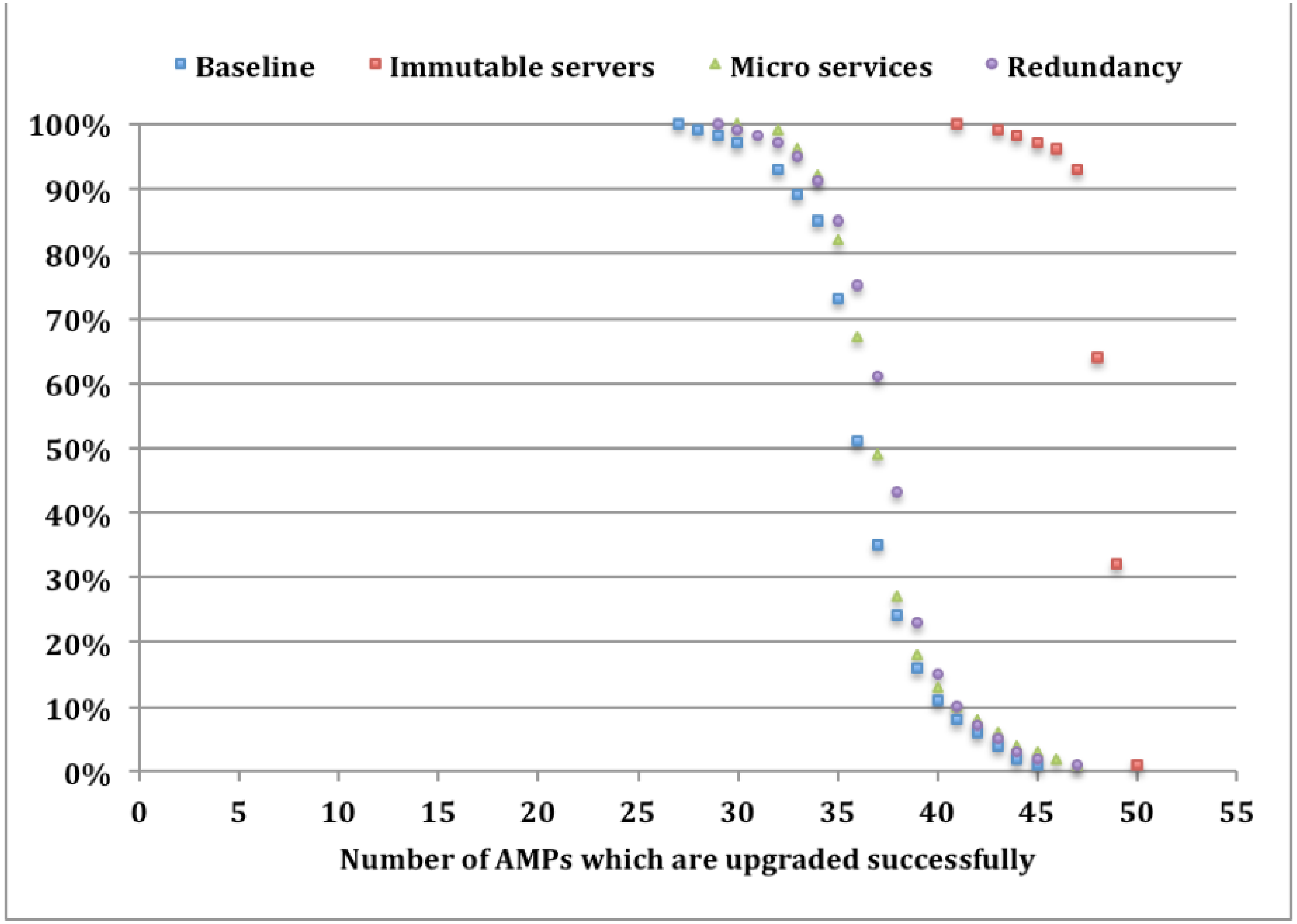
## Evaluation of Deployment Architecture Tactics

- We evaluate the deployment architecture tactics through automatically upgrading 50 AMP stacks (Apache + MySQL + PHP) by shell scripts.
  - ran on EC2
  - upgrades the AMP stack from Apache 2.0.65, MySQL 5.1.73, and PHP 5.2.17 to Apache 2.2.22, MySQL 5.5.35, and PHP 5.3.10 respectively.

## Evaluation of Deployment Architecture Tactics

- We implemented the three deployment tactics, and compared the number of the successfully upgraded VMs using different tactics with a baseline, which represents upgrade without any tactics.
- Ran each of the 4 test cases 100 times
  - Baseline: upgrade AMP running on 50 VMs to the recent versions directly on the original VMs.
  - Immutable server: create an image of VM which runs the new version of AMP and launch 50 VMs using the image. Then we terminate the VMs running old versions of AMP.
  - Micro services: run Apache and PHP on 50 VMs and run MySQL on another 50 VMs, then we upgrade them on the original VMs directly.
  - Redundancy: launch 3 extra VMs with AMPs before we do upgrade. After the 3 extra VMs are successfully launched, we start upgrading the 53 VMs with AMPs.

# Evaluation of Deployment Architecture Tactics



**Measurement results of deployment tactics.**

## Conclusions

- We proposed API mechanisms and deployment architecture tactics to tolerate long-tail issues of operations in cloud
- We implemented our mechanisms as a tail-tolerant wrapper around EC2 APIs
- Our initial evaluation shows that the mechanisms and deployment architecture tactics can remove the long tails
- Future work:
  - implement the rest of mechanisms in API wrapper
  - model the reliability of cloud operations in SRN

*Thanks you!*

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