

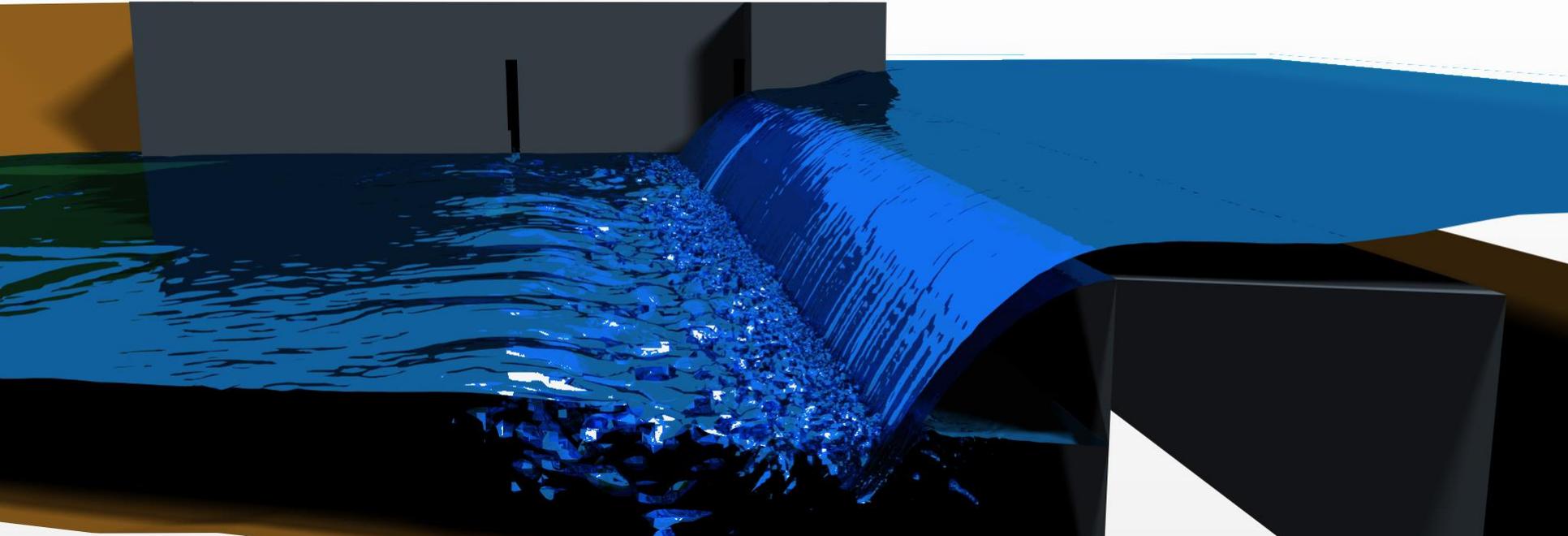


CLIENTS | PEOPLE | PERFORMANCE

# Adventures in Cloud Computing

## Commercial CFD Perspective

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# GHD Who are we?

Professional services company with >10,000 employees.  
100% employee owned.

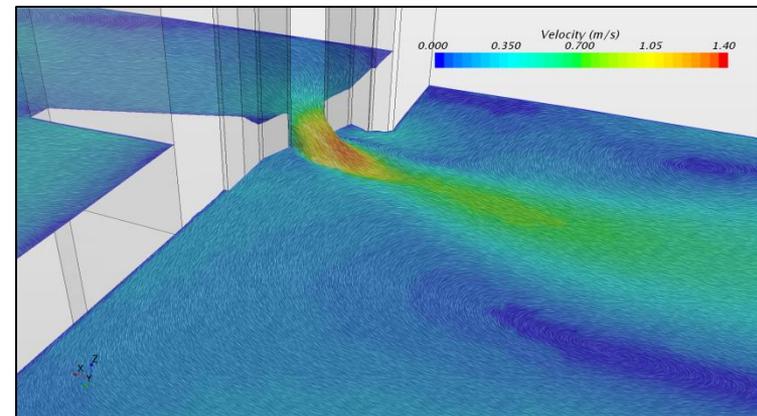
Melbourne office 350 staff.

CFD team consists of around 10 people.

Distributed across Australia and USA, 4 in Melbourne.

Growing team and workload.

CFD modelling work covers a range of industries, focused on water and dams.



# Purpose of Presentation

Share the progress and experiences of our small group.

Motivations, ease of use, performance.

Cover positive and negative aspects.

Hopefully provide some useful information for those looking to get into cloud compute.

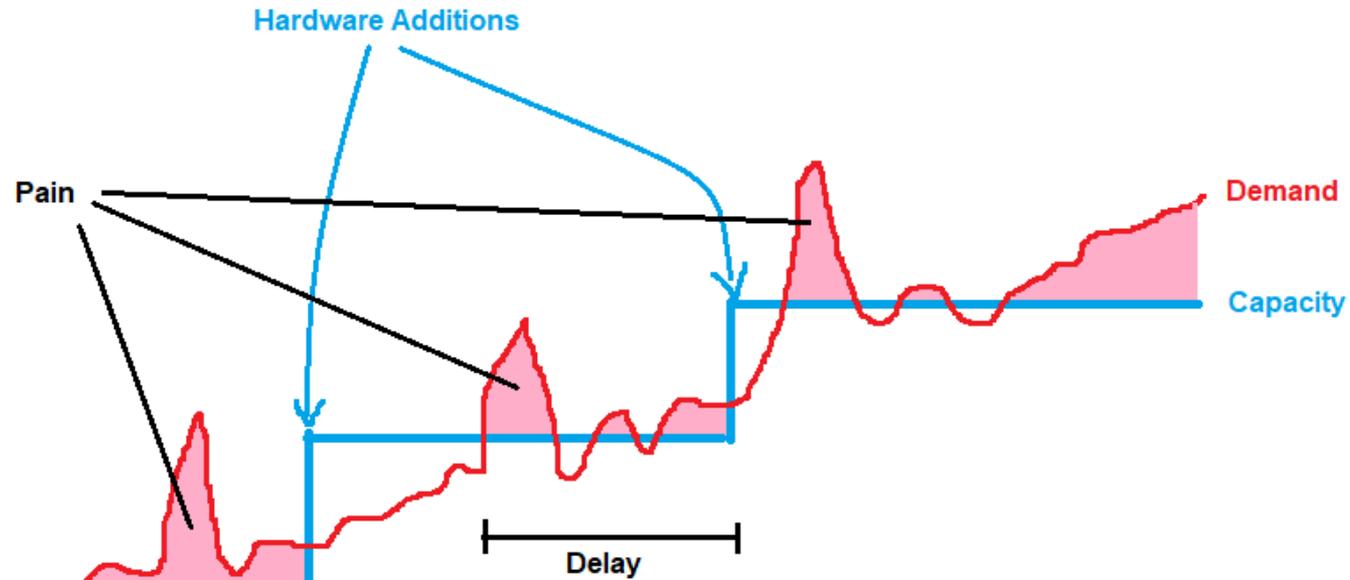
This will be a short presentation!



# Why the interest in Cloud compute?

Part 1 – Reduce Growing Pains

demand / capacity



time

# Why the interest in Cloud compute?

Part 2 – Deliver Fast

## Innovative Debris Collection and Removal System



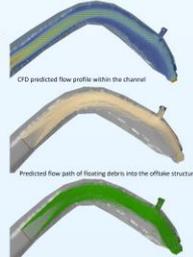
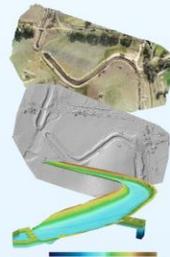
### Introduction

- Southern Rural Water (SRW) recently constructed new irrigation supply pipelines to replace existing open supply channels in the Tinamba region.
- Works included a new channel offtake structure with inclined trash racks to prevent debris entering the pipelines.
- During the 2018 irrigation season, SRW found that *daily manual cleaning* of the trash racks was required in order to clear the significant build-up of debris.
- For the 2019 irrigation season the flow through the offtake will increase four-fold
- SRW were therefore seeking an improved debris collection and removal system which could both minimise the amount of debris entering the offtake, and reduce effort for operators required to maintain the offtake structure
- GHD were engaged to investigate and design these improvements



### Investigation

- Drone LIDAR (imagery of the irrigation channel and CAD drawings of the offtake structure) were used to build an accurate geographical computer model of the channel and offtake structure
- CFD modelling was used to predict the flow profile within the irrigation channel to help understand the path of debris transportation into the offtake structure itself
- The future four-fold increase in flow through the offtake was also modelled in order to predict the future flow profile and effects of this on debris transportation into the offtake.
- This CFD modelling using the existing channel geography and future flow conditions indicated that:
  - The flow is heavily concentrated on the northern bank of the channel which contains the offtake structure
  - A significant increase in debris transportation into the offtake structure is expected due to the increased offtake flows for 2019

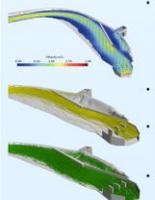


CFD model bathymetry of the irrigation channel generated from Drone LIDAR imagery

### Solutions

#### Diversion Wall

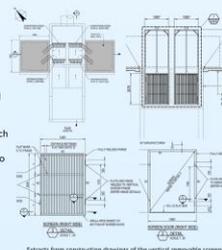
- CFD simulations predicted that deploying a semi-permeable diversion wall and floating boom within the irrigation channel would prevent debris-laden flows from directly entering the offtake structure.
- Hydraulic capacities would still be met, ensuring supply for downstream customers
- Diversion of floating debris is expected to be very good, though diversion of suspended debris is expected to be less effective.
- The ultimate effectiveness at diverting suspended debris will depend on the permeability of the wall and its ability to remain permeable throughout the irrigation season.



CFD predictions of the channel flow profile, and of floating and suspended debris path within the channel with diversion wall and boom deployed

#### Removable Vertical Screens

- A series of removable vertical screens was designed to replace the old inclined trash screens.
- Key features of the Removable Vertical Screens developed include:
  - Design for static loads and Live Loads/Wind Loads
  - 24V (battery + solar) motor/gearbox and drive rack of minimum 500 kg lifting capacity for screen extraction
  - Two screens installed in series within each half of the existing offtake structure
  - Hinged arrangement to enable screens to be swung to the edge of the offtake structure for cleaning
- These screens eliminate the need for operators to manually rake debris from within the offtake structure, while still protecting the pipeline and downstream assets from the negative effects of debris



Extracts from construction drawings of the vertical removable screens



Timelines are rarely reasonable.

Example project:

- Monday, identify issue.
- Tuesday, drone survey.
- Wednesday, model build and run existing conditions.
- Thursday, simulate options.
- Friday, advise client, provide design.
- Following Friday, construction complete, operating.

# The Learning Curve:

Open an AWS account.

Robin Knowles (CFD Engine) Openfoam/AWS online training course, \$79.

Play around with free-tier single instance simulations and Openfoam.

Try configuring conventional cluster, discover AWS ParallelCluster.

Start setting up multi-instance clusters, get approval for larger cluster sizes.

Benchmarking, customization, testing including StarCCM+.

Commence commercial usage (~3-4 months later, novice starting point).



# ParallelCluster:

Open source project used to automate creation of cloud clusters.

Previously known as CfnCluster.

Takes care of almost all configuration on AWS side.

Requires some specific configuration for effective CFD usage.

Need to make custom linux images if using commercial CFD software.

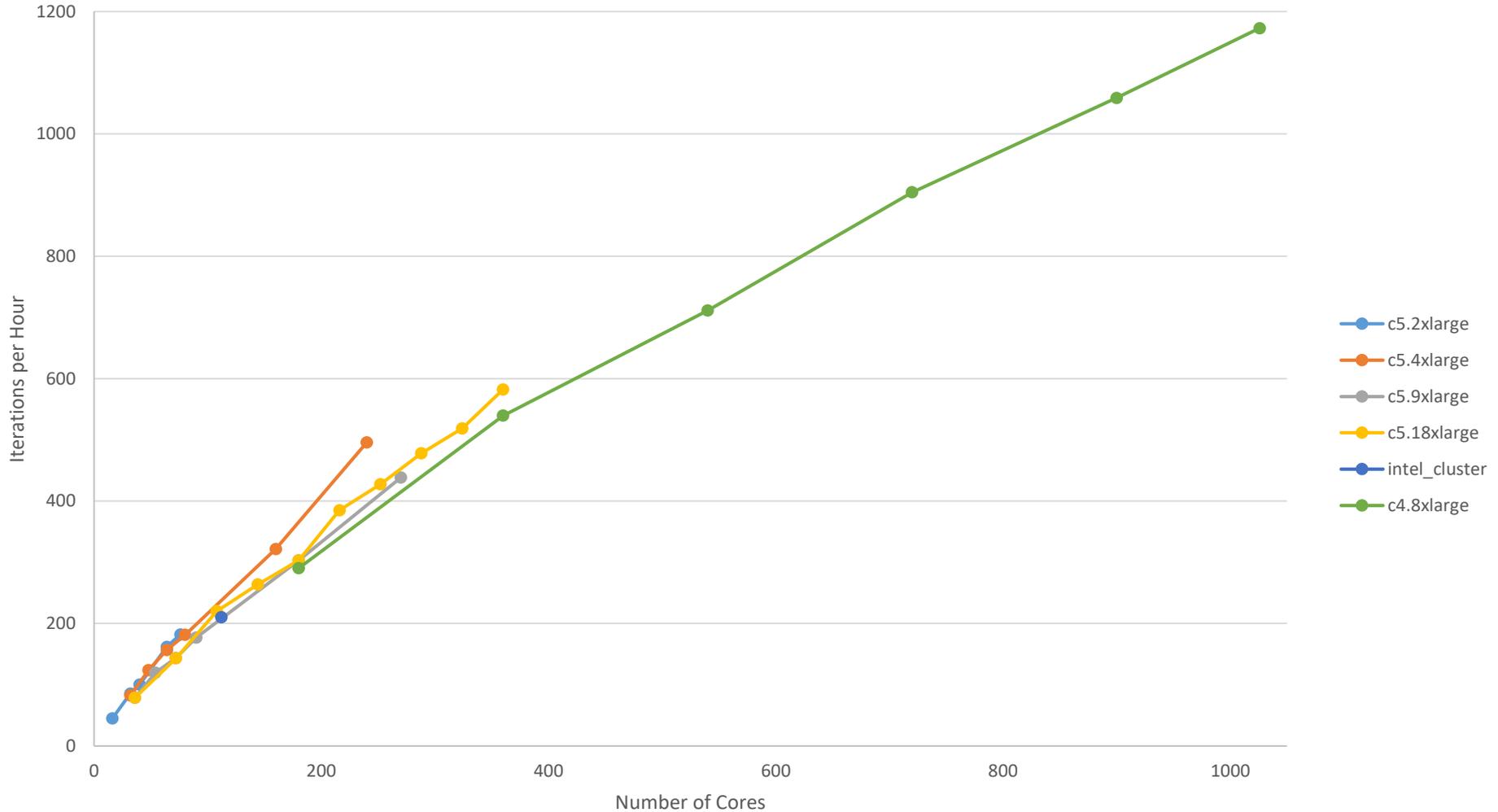
Highly recommend a linux 'jump box' to create and manage clusters.

Includes queue management software.



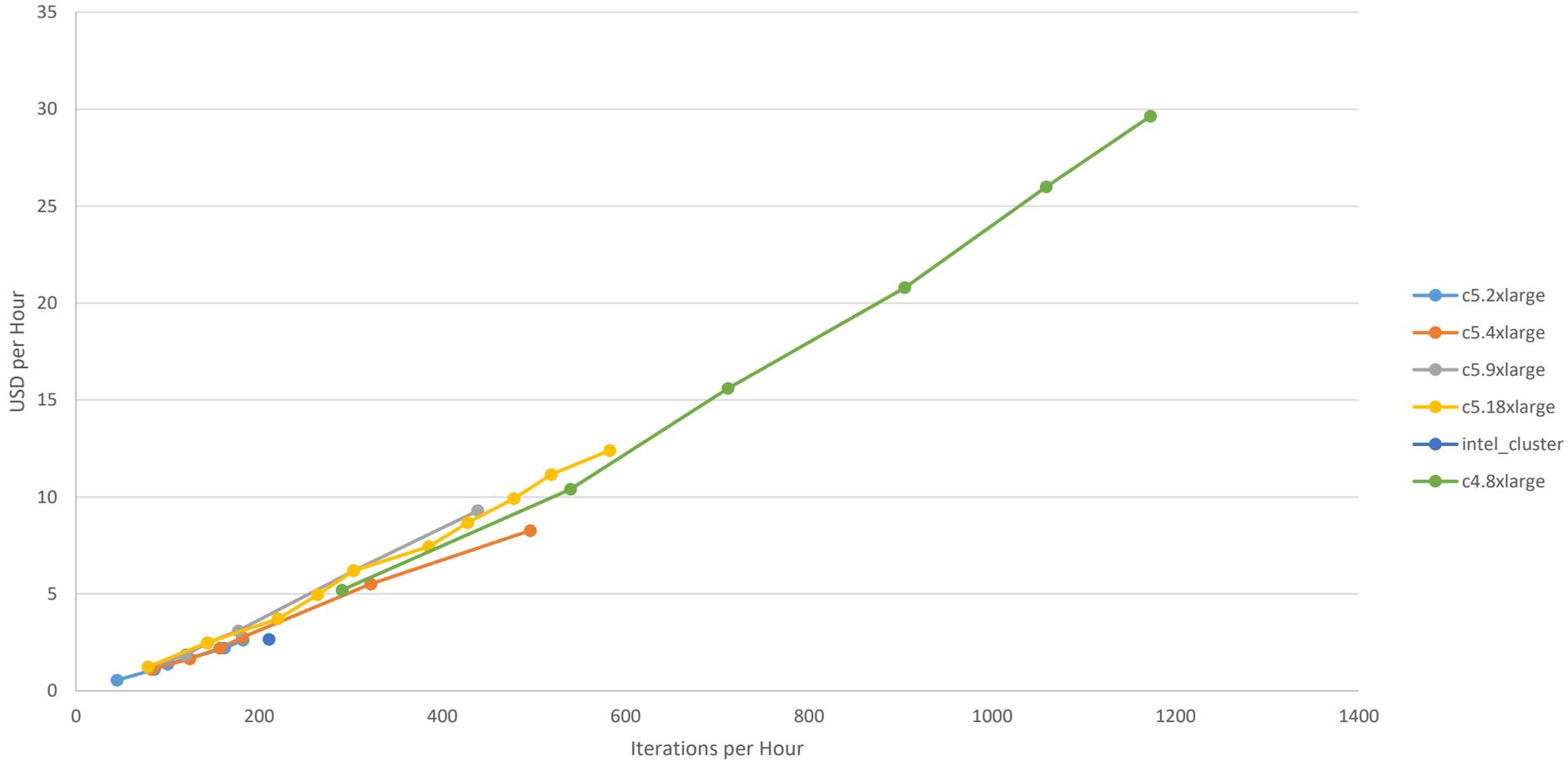
# Performance (Scaling)

Cluster Size Comparison



# Performance (Economic)

Spot Price Economic Performance



## Typical setup:

Usually run on one or two 900 core clusters (cluster with 50 nodes).

License costs dominate economics, make larger clusters more desirable.

Use c4.8xlarge instances.

*We learned:*

*Need to do your own testing (model type, vendor, mesh size, etc).*

*Be skeptical of 'cells per core' guidelines and other rules of thumb.*

*The best configuration will change (waiting for AMD Rome release with interest).*



## **Conclusions:**

Competitiveness of cloud computing for CFD improving with time.

Usability is expected to improve with time, fairly manual process at the moment.

Tools are available to make life easier.

Being used actively as part of a hybrid in-house and cloud compute strategy.

Will continue to monitor the performance and economics of cloud computing and will adjust our strategy accordingly.

Cloud computing requires a shift in modelling methodology (the compute resources aren't free!).





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