

# web scaling frameworks

A novel class of frameworks for scalable  
web services in cloud environments



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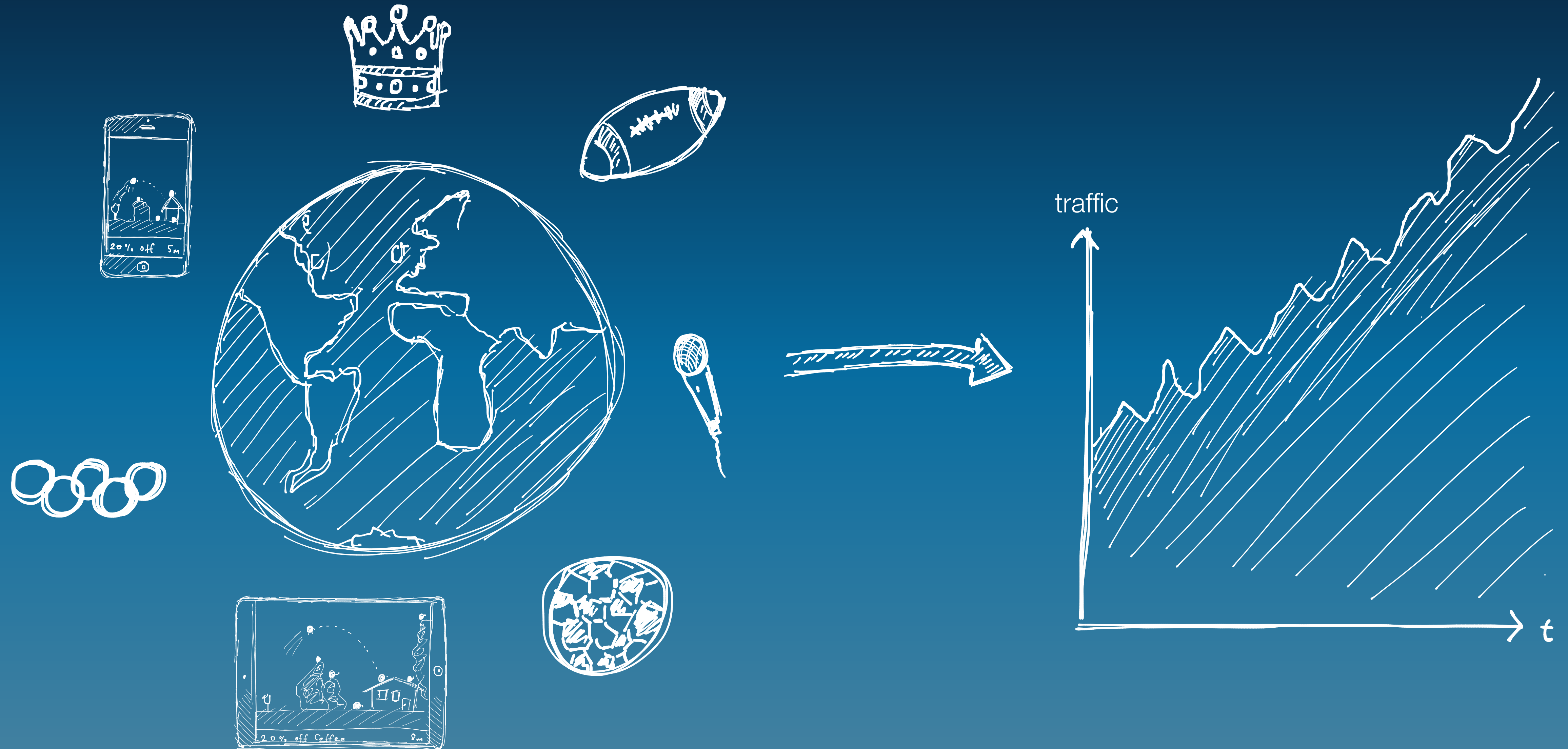


An aerial night photograph of a city skyline, likely New York City, featuring numerous illuminated skyscrapers and a body of water in the background under a twilight sky. The word "background" is centered in white text.

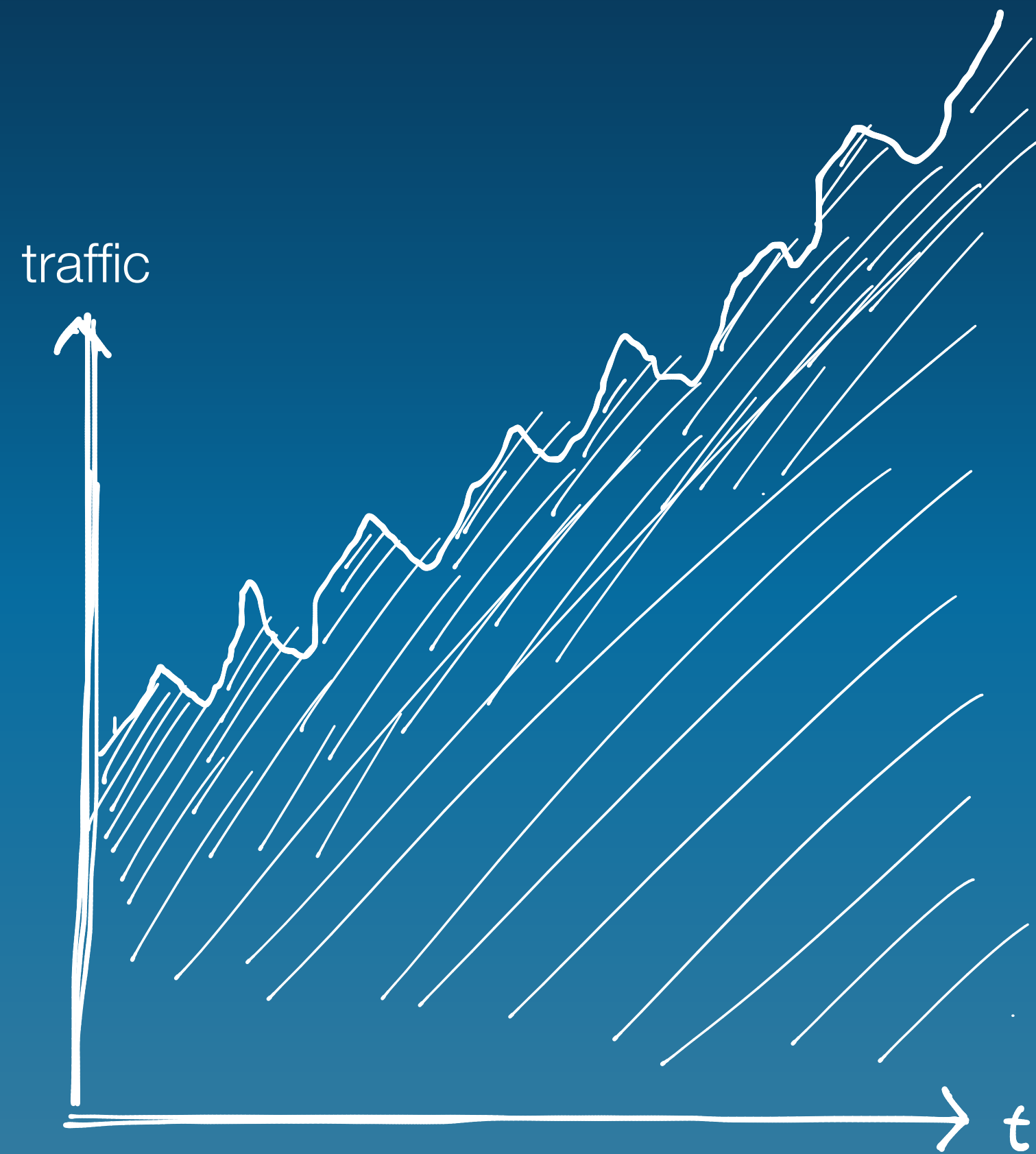
background



# background



# background





An aerial night photograph of a city skyline, likely New York City, showing a dense cluster of illuminated skyscrapers and a body of water in the background under a twilight sky. The word "challenges" is centered in the image in a white, sans-serif font.

challenges



# challenges

+ modularized and distributed web applications

*who manages the distribution components?*

+ application logic vs. hosting logic

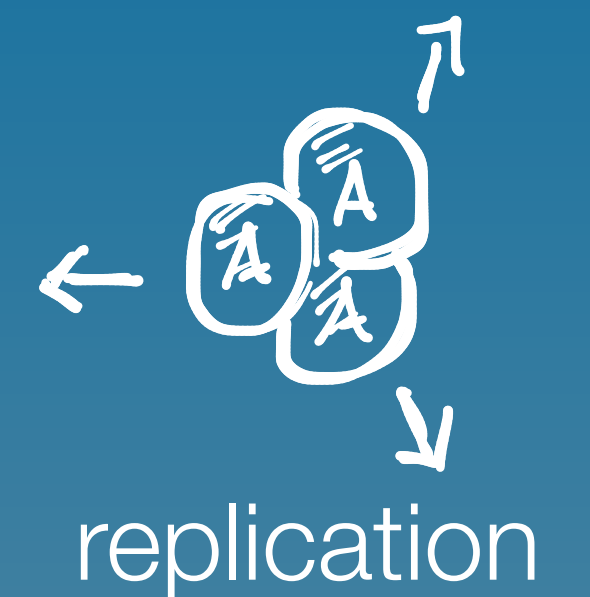
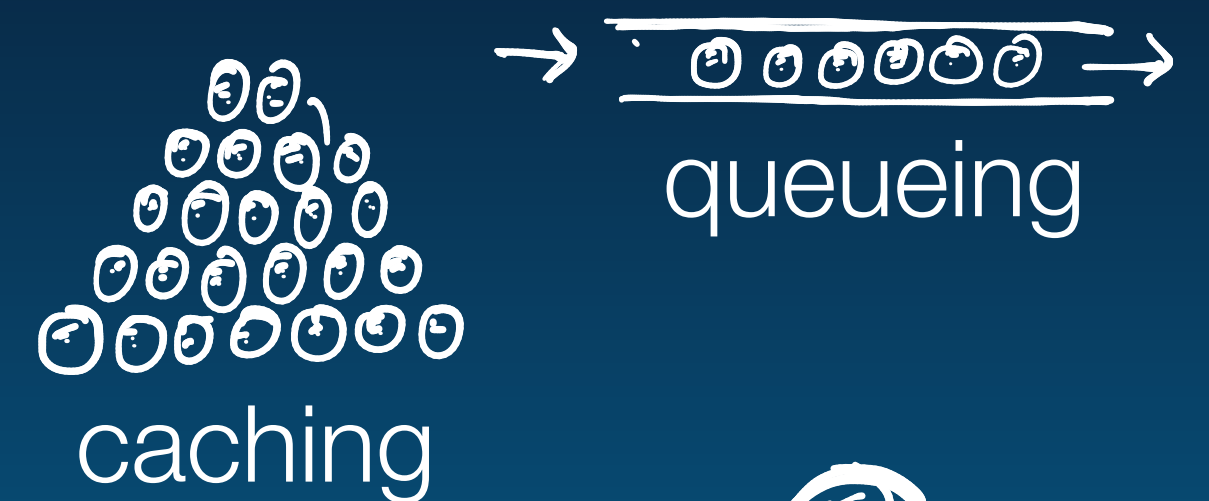
*how much does the app need to know?*

+ scaling considerations

*when to implement scaling?*

+ performance prediction

*how much of what components are / would be needed?*



# There is a lot of relevant research for each component

- + but, we propose to combine those complementary components to a predictable, composed system

- + general concept  
*web scaling frameworks*

- + prototype  
*mathematical model and empirical data*

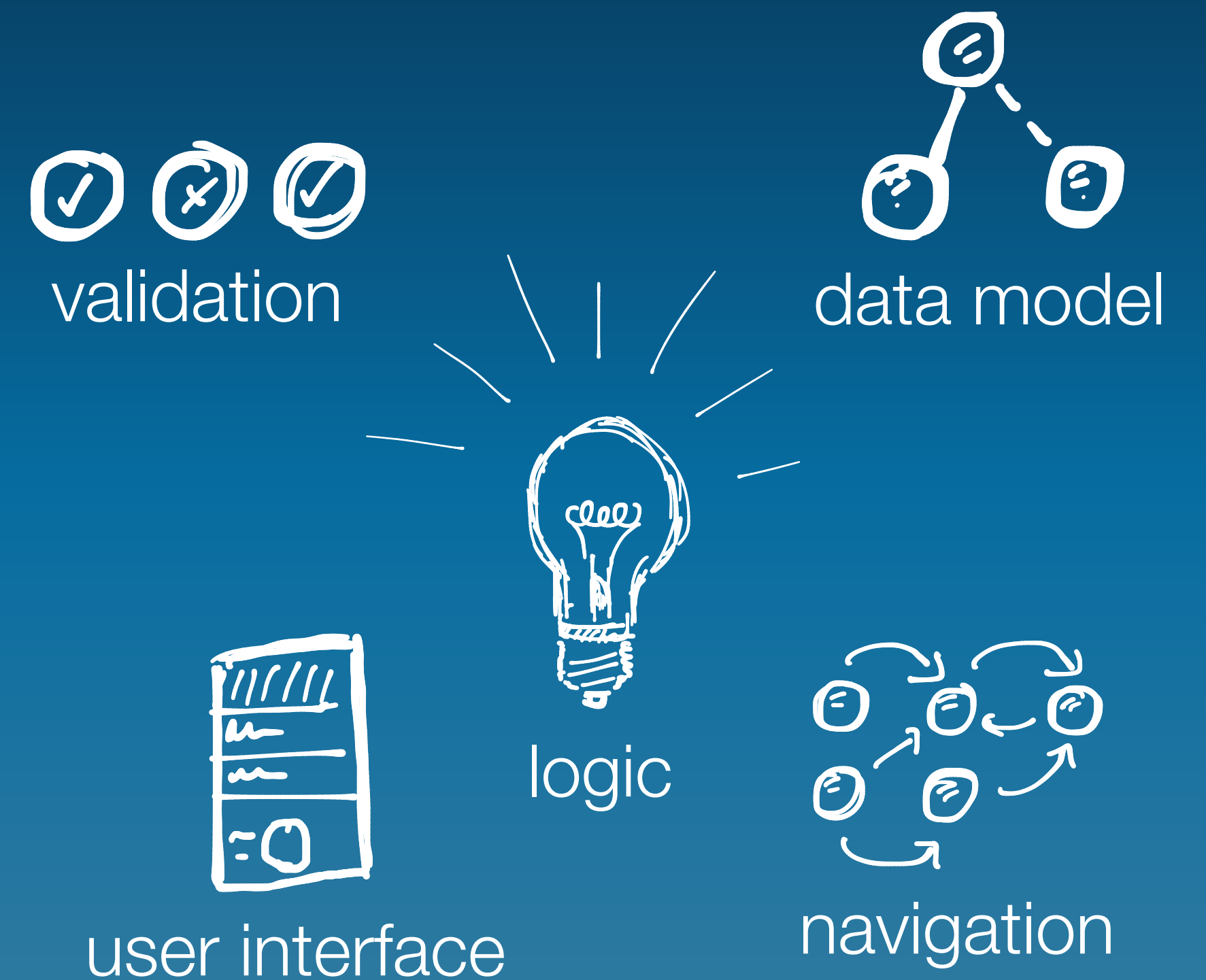
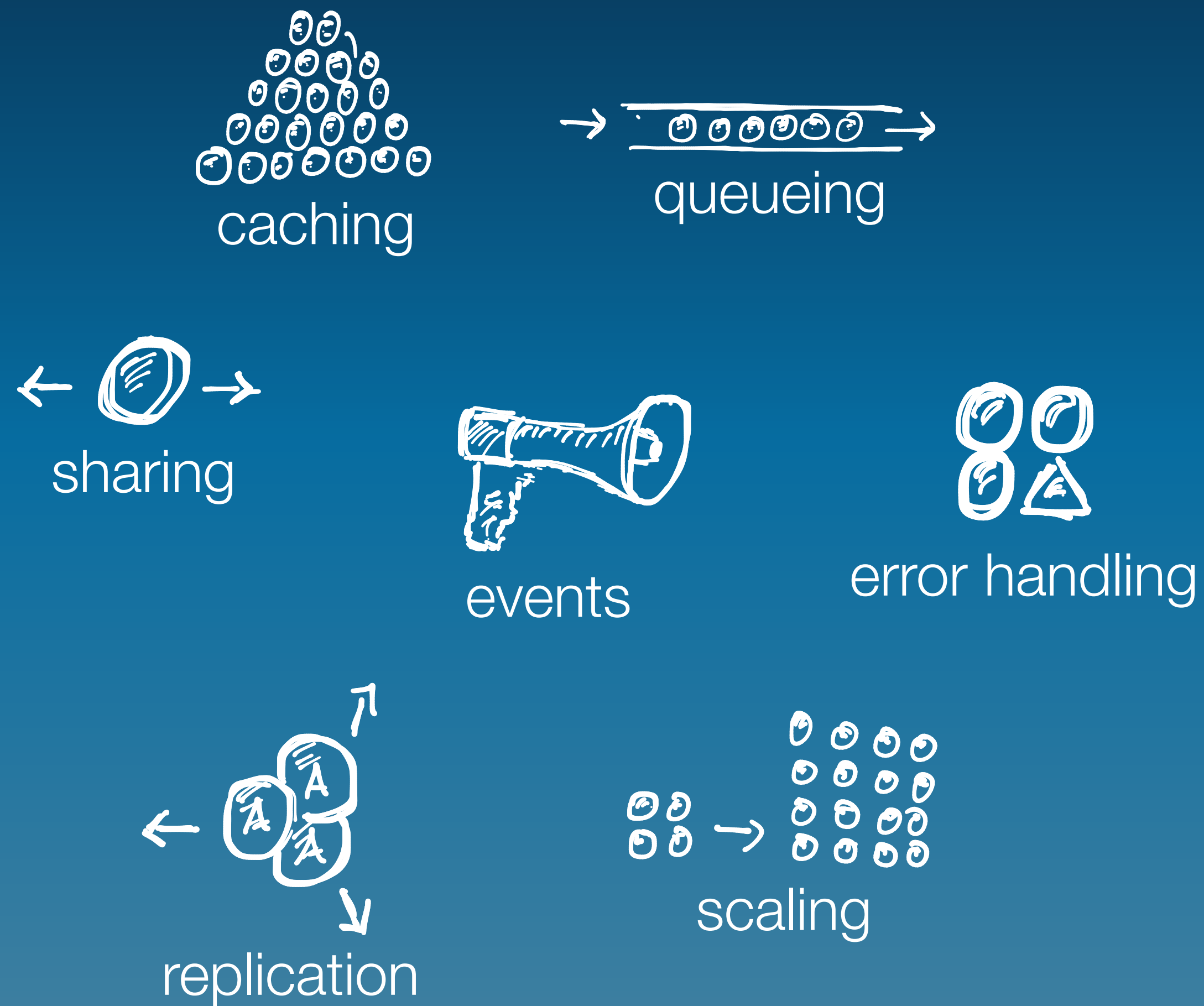


An aerial night view of a city skyline, likely New York City, with a sunset sky in the background. The city lights are visible, and the water of the harbor is in the foreground. The text "web scaling frameworks" is overlaid in the center.

# web scaling frameworks

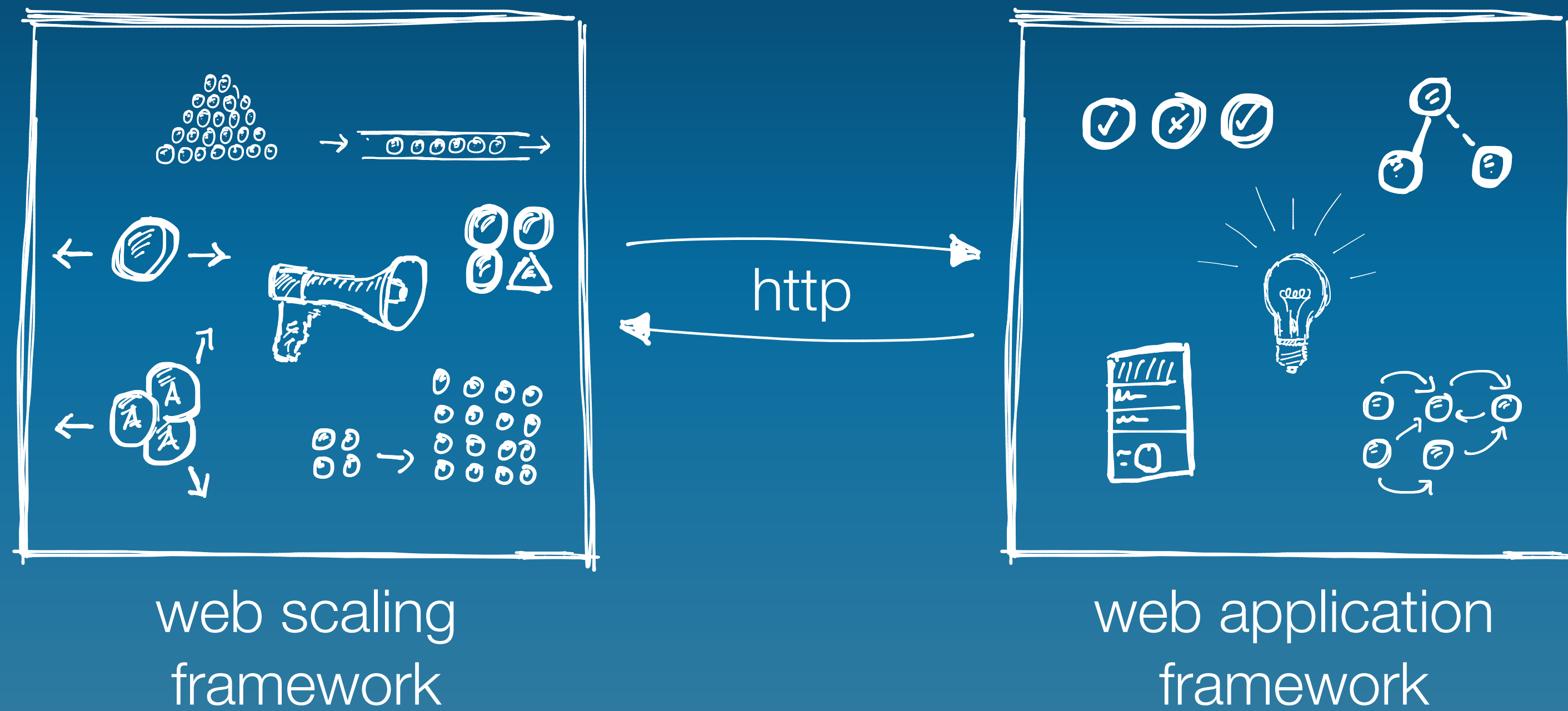


# web scaling frameworks





# web scaling frameworks





# web scaling frameworks

- + take over scaling

*separate application logic from hosting logic*

- + predict and manage performance

*monitor and control*

- + connect to existing web application frameworks

*http as interface, not a replacement*



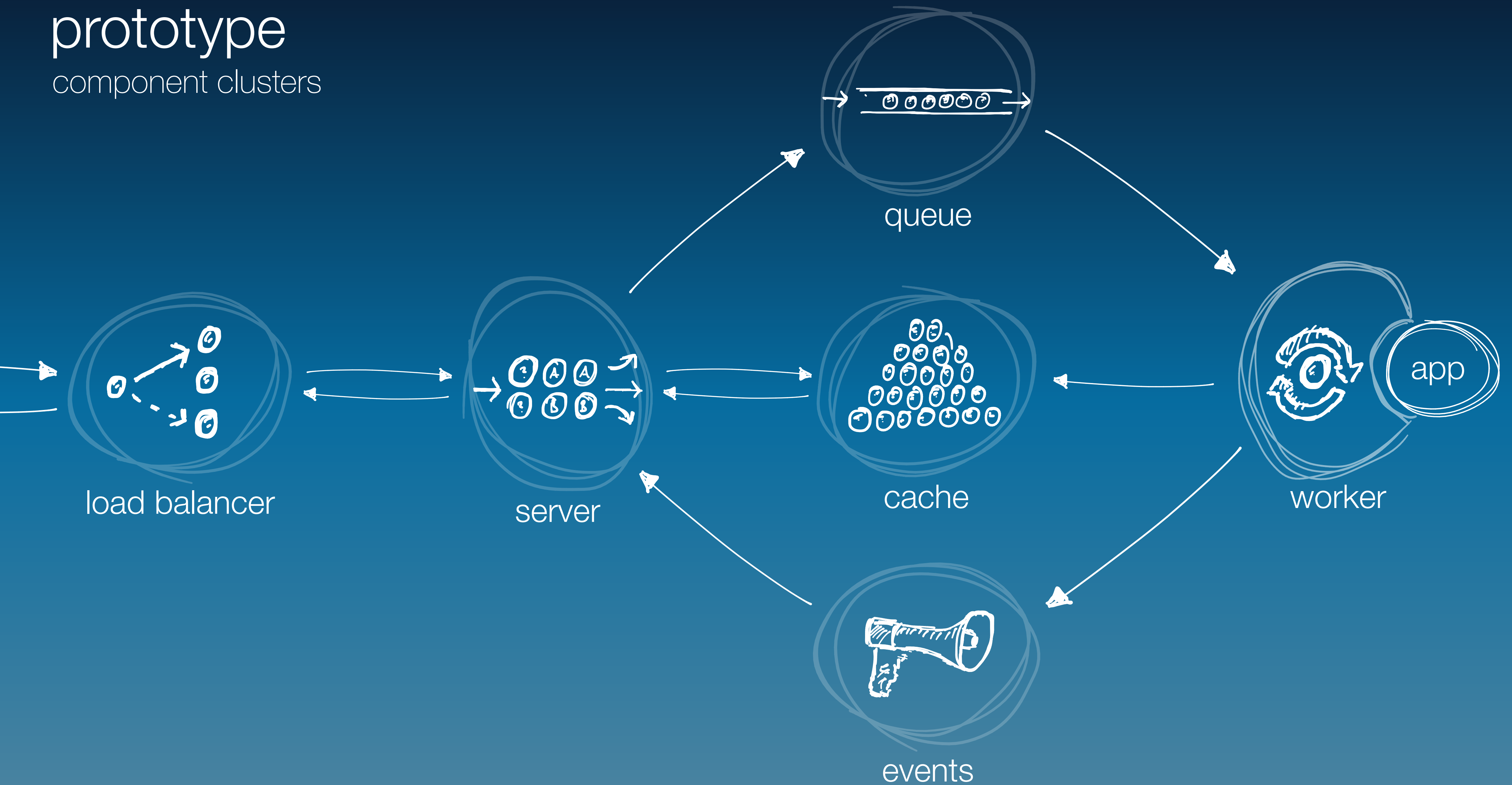
An aerial night photograph of a city skyline, likely New York City, featuring numerous illuminated skyscrapers and a body of water in the background under a twilight sky. The word "prototype" is centered in white text.

prototype



# prototype

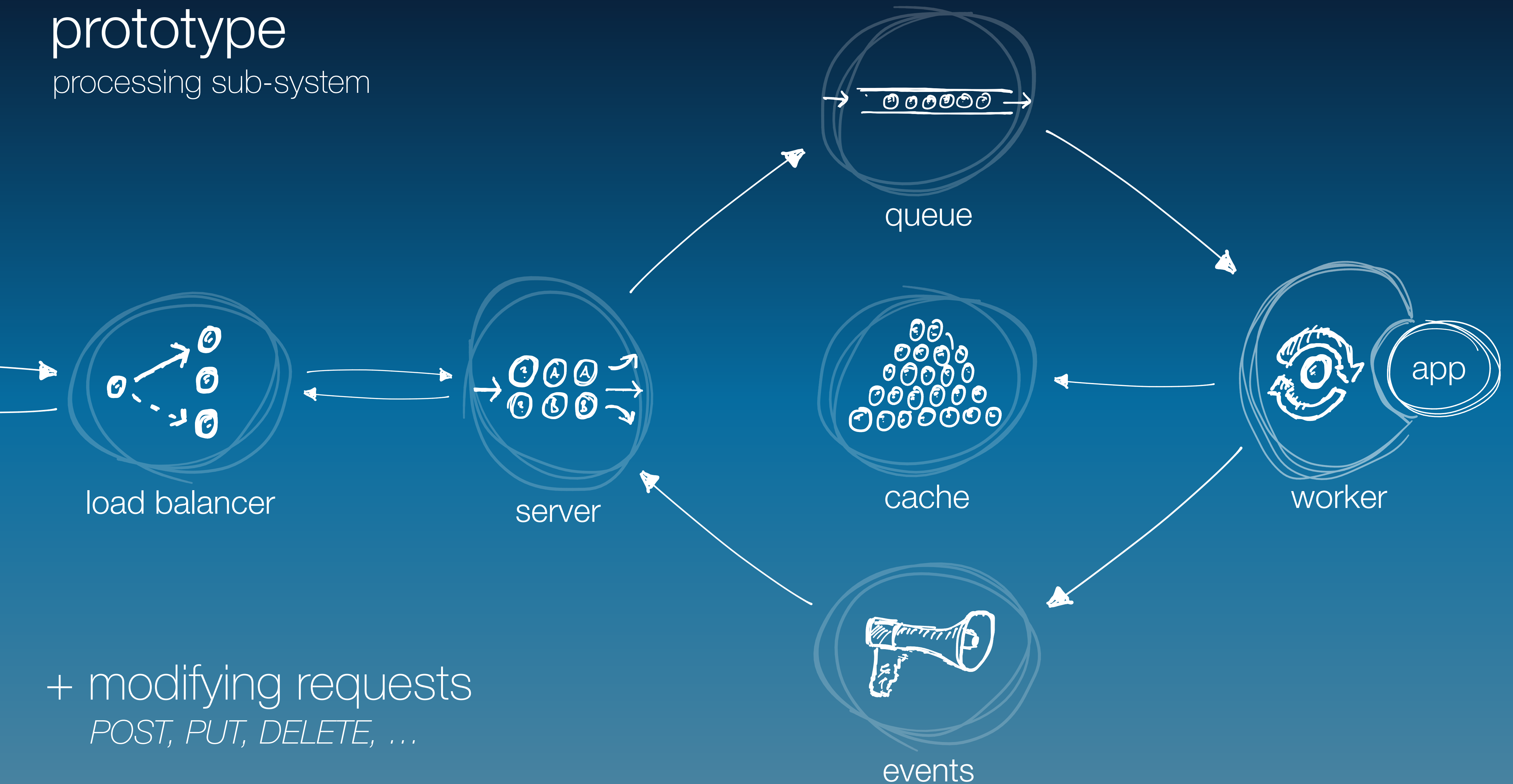
component clusters





# prototype

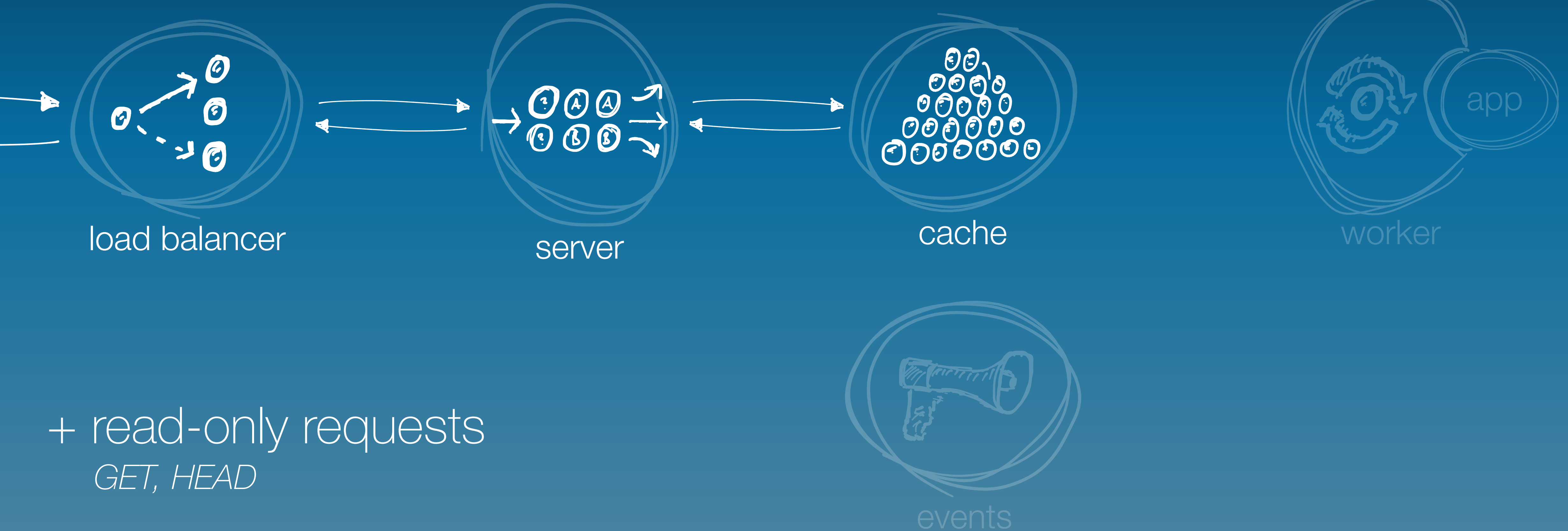
processing sub-system





# prototype

read sub-system



+ read-only requests

*GET, HEAD*



# Caching everything is impossible

+ but, for most applications it isn't...

+ application design matters

*design for cacheability*

+ fast cloud storage is available

*storage is cheaper than compute units*

+ post-processing

*mechanism that keeps resource dependencies updated*



# prototype

post-processing

- + worker and app are on the same host  
*connect web scaling framework and web application framework*
- + worker offers interface to app  
*register dependency, push content, ...*
- + application declares resource dependencies  
*synchronous and asynchronous dependencies*
- + worker ensures updates of dependencies  
*optimises and resolves update tree*





# prototype

post-processing example

+ app: create blog post dependencies

*synchronous: /index*

*asynchronous: /sitemap*

+ worker: POST /posts

- 1. sends request to app*
- 2. receives and stores sync. and async. dependencies*
- 3. pushes updates to the cache*
- 4. recursively resolves sync. dependencies*
- 5. forwards response to event system ... client*
- 6. recursively resolves async. dependencies*





An aerial night photograph of a city skyline, likely New York City, showing a dense cluster of illuminated skyscrapers in the foreground and a body of water in the background under a twilight sky. The word "evaluation" is centered in the image in a white, lowercase, sans-serif font.

evaluation



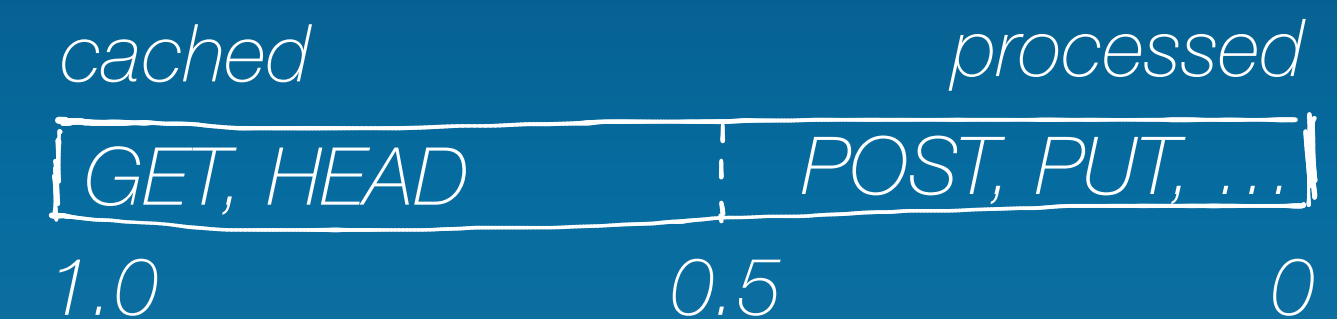
# evaluation

- + mathematical model

*component delays and sub-systems*

- + cache / processing ratio (CPR)

*traffic distribution ratio between 1 and 0*



- + scaled version vs. normal version

*web scaling framework + web application framework vs. web application framework*

- + empirical data collection

*single machine scope and multi-machine scope*



# evaluation

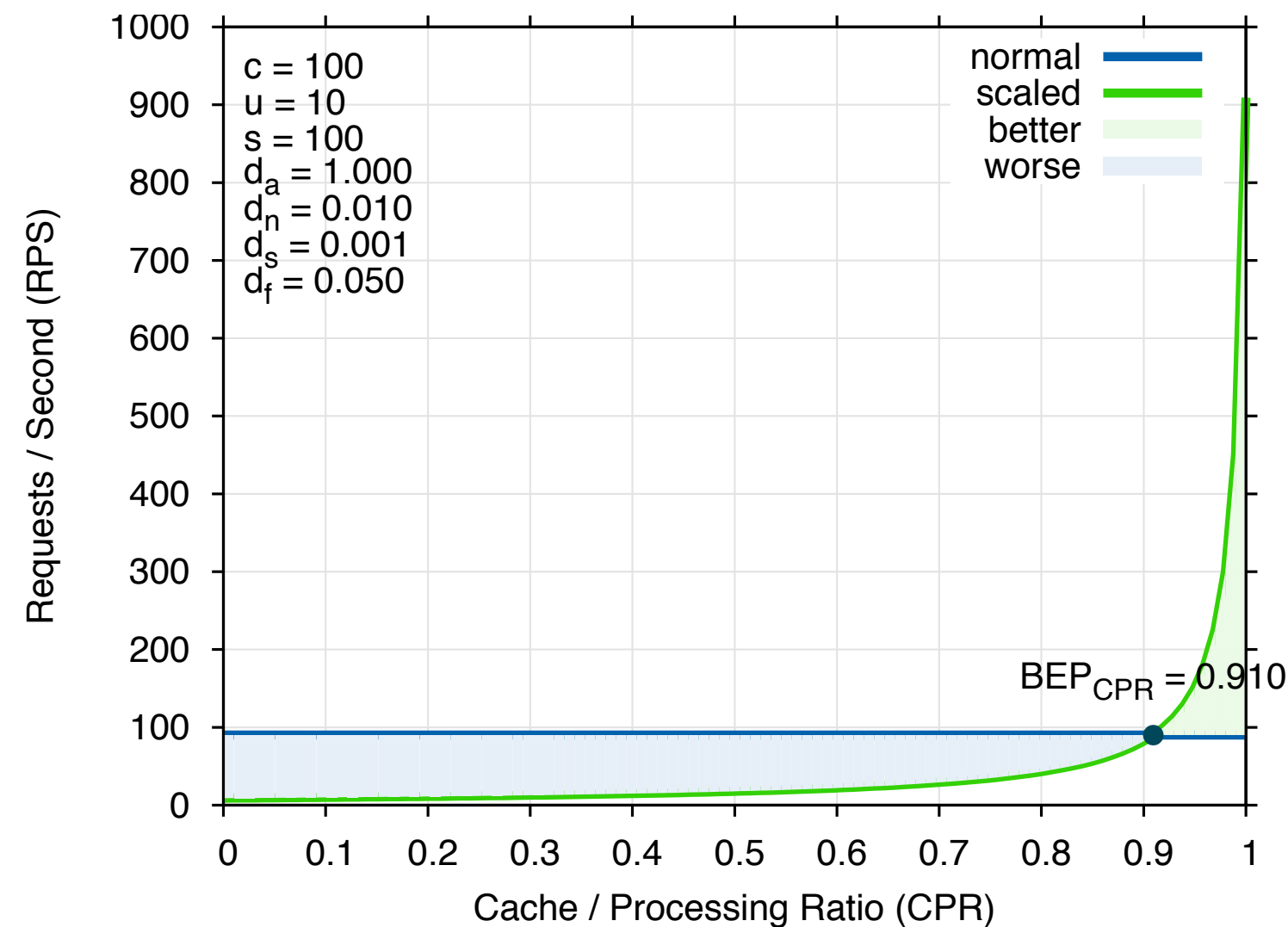
+ mathematical model: analytical prediction

*normal version does not consider cpr*

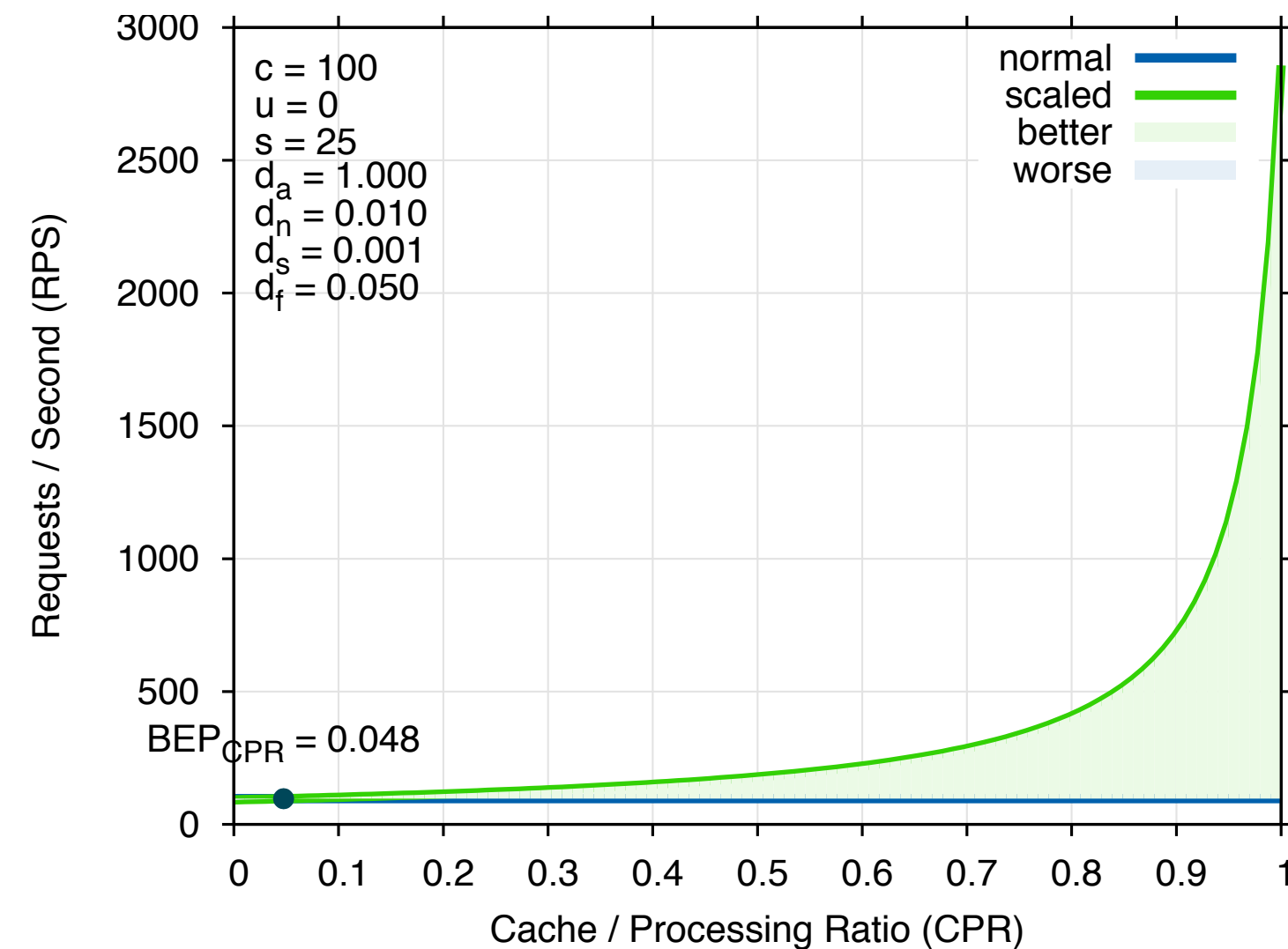
on a single machine

*all components on same host*

worst case

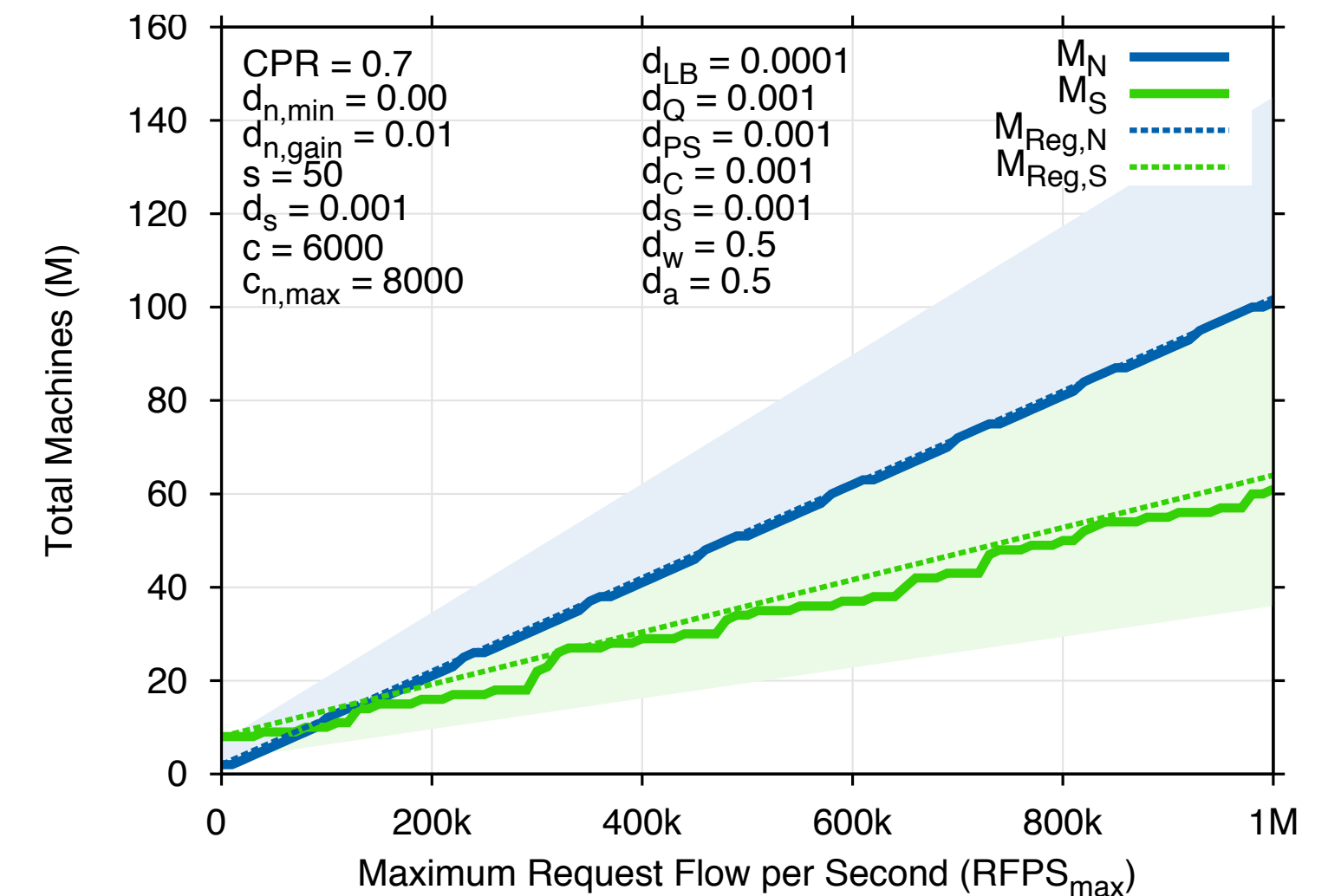


best case



on multiple machines

44% fewer machines





# evaluation

## + empirical data collection

*normal version vs. scaled version - single machine scope*

$V_n$ : normal version vs.  $V_s$ : scaled version

## + 81 parameter tuples

*cpr, da, s, u*

$CPR = (1.0, 0.5, 0.0)$

$da = (0.0, 0.5, 1.0)$

$s = (25, 50, 100)$

$u = (0, 5, 10)$

## + expected the cpr to be highly influential

*$V_s$  expected to be better for tuples where  $CPR = 1.0$*

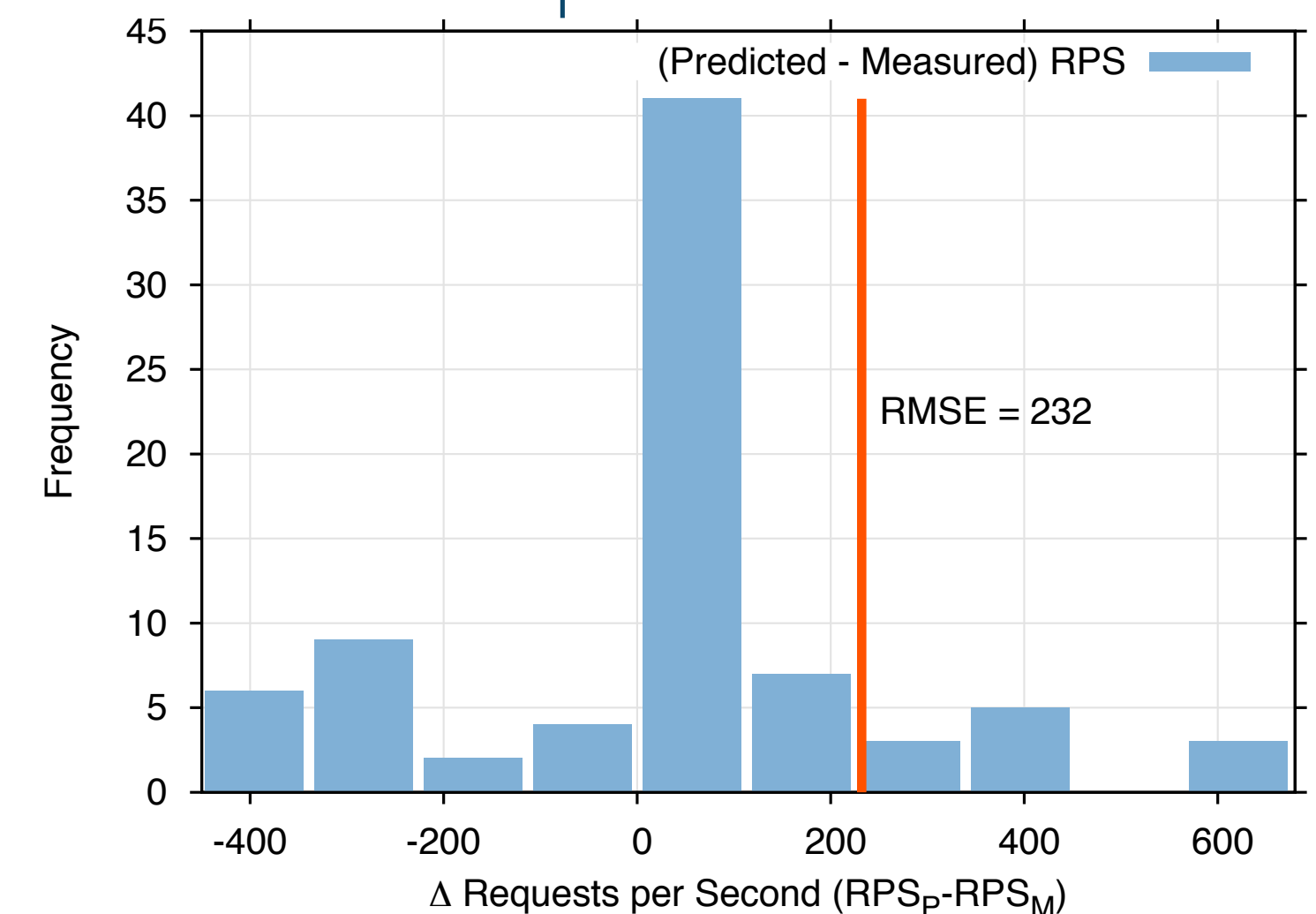
*$V_n$  expected to be better for tuples where  $CPR = (0.5, 0.0)$*

## + hypothesis: In 33% $V_s$ performs better than $V_n$

*accepted with a result of 37%*

model vs. data

97.6% prediction fit





An aerial night view of a city skyline, likely New York City, with a sunset sky. The foreground shows a dense cluster of illuminated skyscrapers, including the Empire State Building. A body of water, possibly Central Park or a harbor, is visible in the middle ground. The sky transitions from a deep blue at the top to a bright orange and yellow glow near the horizon. The text "in progress" is centered in the middle of the image.

in progress



# in progress

- + empirical data collection

  - multi-machine cloud scope*

  - raspberry pi cluster of 42 machines*

- + further implementations

  - web scaling frameworks*



An aerial night view of a city skyline, likely New York City, with a sunset in the background. The sky transitions from a deep blue at the top to a bright orange and yellow glow along the horizon. The city below is illuminated by numerous lights from buildings and streets, with a prominent highway interchange visible on the left. The text "thank you!" is centered in the middle of the image in a white, sans-serif font.

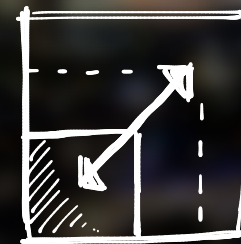
thank you!



thank you!

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