Building for rapid scale: A deep dive into The New York Times messaging platform

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Overview

1. Why Messaging is Important
2. Messaging at The NYT
3. Demand for a Better System
4. Building for Rapid Scale
5. Performance
4.2 Billion Emails Delivered in 2019

53 Newsletters

nytimes.com/newsletters
~ 9 Million Subscribers

~ 4 Million Subscribers

4. 2 Billion Emails Delivered
After hundreds of passengers were allowed to disembark from a cruise ship in Cambodia, an American tested positive for coronavirus.

President Xi Jinping knew of the coronavirus outbreak well before he spoke of it, drawing him directly into questions about China’s delayed response.

A 14-year-old boy was charged with second-degree murder in the killing of Tessa Majors, a Barnard student, during a robbery in December.

Michael Bloomberg’s charitable giving soared as he eyed a presidential run. We examined how his billions created an unmatched empire of influence.

France announced the first coronavirus death outside Asia. An 80-year-old Chinese tourist died at a hospital in Paris on Friday.

The U.S. will evacuate Americans from a cruise ship that has been quarantined in Japan for over a week because of coronavirus fears.

A lot went wrong at the Iowa caucuses. We checked the raw vote counts to find where the math didn’t add up.
7 channels

50 Million Devices
Messaging is important

- Journalism and Business
- Great tool to engage with our readers
- Communication works both ways
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Two systems

Newsletters

Push Notifications
Models

- Campaign
- Product
- Audience
- Schedule
- Message
Platform Capabilities

- Subscribe users to products
- Administer products, campaigns, audiences, schedules, messages
- Send a campaign
- Reporting
Platform Architecture

- **Admin**
  - **Admin DB**
- **Campaigns**
- **Dispatcher**
- **Messages**
  - **Compile Send**
- **User Subs**
  - **Audience**
  - **Delivery Logs**
  - **Reporting**
Why Build it in-house?

- Control of our data and our users data
- Light Vendor Lock-in
- Flexibility in developing new features
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Revise Platform Architecture

- Handle Newsletters and Push Notifications
- Rapid growth in Newsletter Audiences
Deliver Newsletters of growing audiences

Largest audience: 2 Millions
SLA to deliver: 10 minutes

Largest audience: 9 Millions
SLA to deliver: 10 minutes
Rapid growth in Newsletter Audiences

TOTAL SUBSCRIBERS
Total number of readers who are subscribed on a given day.

Subscribers on 2020-02-16

4,132,673
2.37%

Yesterday versus 1 month prior
Rapid growth in Newsletter Audiences

DAILY
Morning Briefing
What you need to know to start your day, delivered to your inbox.

See the latest

Total Subscribers
Total number of readers who are subscribed on a given day.

Subscribers on 2020-02-16
8,509,539 19.16%
Yesterday versus 1 month prior
● Deliver Push Notifications

Largest audience: 50 Millions

SLA to deliver: 2-3 minutes
Bottlenecks

Admin DB → Admin → Campaigns → Dispatcher → Messages

Admin DB → User Subs → Audience → Delivery Logs → Reporting

Compile → Send
Bottlenecks

- Audiences with more than 1 Million rows take longer than a minute to read and dispatch.
- Due to GAE instance limitations can’t process audiences larger than 10 million rows.
Bottlenecks

- Service latency impacts throughput
- Many messages wait to be processed and get retried
- How fast can we detect the load to scale quickly and process all requests?

Maximum number of requests \( \times \) Maximum number of instances
Scaling Horizontally vs Vertically

Vertically

![Diagram showing the difference between horizontal and vertical scaling]
Scaling Horizontally vs Vertically

Horizontally

[Image of processor icons showing horizontal scaling]
Scaling Horizontally vs Vertically

Vertically
- Cannot use GAE
- Inflexible
- Failure means we have to try sending entire campaign
- Stateful

Horizontally
- GAE
- Flexible
- If one machine fails it’s the one to retry
- Stateless
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Scale How We Dispatch the Audience

- Must know state. A campaign should not fail because of a failure to load DB page.
- Must process all rows in 1 minute.
- Must retry to load data if request fails
Scale How We Dispatch the Audience

- A Service that’s stateful
- A Stateless Service that can scale to many instances
- Audience can be read in parallel using subqueries
Scale How We Dispatch the Audience

Campaigns → Orchestrator → Audience

- Dispatcher
- Dispatcher
- Dispatcher
- Dispatcher
Scale How WeDispatch the Audience

Each Dispatcher instance processes the audience from a subquery to the BigQuery DB
How do we Split the Query for the Audience?
Scale How We Dispatch the Audience

<table>
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<th>Category</th>
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<td>Business &amp; Tech</td>
<td>Market-moving news and features.</td>
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<td>Stories from the city, state and region.</td>
</tr>
<tr>
<td>Politics</td>
<td>Fearless coverage of Washington and beyond.</td>
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</tbody>
</table>
Scale How We Dispatch the Audience

Breaking News Push Notifications Channel Subscriptions

Find the window that has enough tokens for a dispatcher instance to process and create a subquery.
Divide & Conquer
Scale How We Dispatch the Audience

- 2015: 10,000,000
- 2015: 2,000,000
- 2017: 8,000,000
- 2015: 1,500,000
- 2017: 500,000
- 2017: 2,000,000
- 2020: 6,000,000
- 2015: 500,000
- 2017: 1,000,000
- 2017: 1,650,000
- 2020: 350,000
Scale How We Dispatch the Audience

500,000

Start Date

End Date

Generated Query

WITH
push_user_data AS (  
SELECT
    push_users.device_token,  
    push_users.device_type
  
WHERE
    update_time >=
    TIMESTAMP('2016-12-17')
    AND update_time <=
    TIMESTAMP('2018-7-12 '))
Scale How We Dispatch the Audience

Admin → Campaigns → Orchestrator

User Subs → Audience → Delivery Logs → Reporting

Dispatcher → Messages → Compile Send
Scale How We Send Messages

- Rate of incoming messages (requests)
- Service Latency
Scale How We Send Messages

Requests 95% Latency: 800ms

Newsletters: Process 1 email/request

Push Notifications: Process batch of messages/request
Scale How We Send Messages

Throughput

\[ 500 \times 80 \text{ requests/instance} = \frac{40000 \text{ req/sec}}{} \]

or \[ 2400000 \text{ req/min} \]

number of concurrent requests / instance
Scale How We Send Messages

Throughput

number of instances

\[ \times \]

number of concurrent requests / instance
Revised Architecture

- Admin
- Campaigns
- Orchestrator
- Dispatcher
- Messages
- Compile
- Send
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Setup

Max Number of Devices/User Ids: 1 Million (1 - 60 queries)

Number of Pub/Subs: ~15 (1000 req/sec)

Compile/Send service Scale Range: 20-500 instances
<table>
<thead>
<tr>
<th>Component</th>
<th>Time Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orchestrator</td>
<td>200ms - 2 seconds</td>
</tr>
<tr>
<td>Dispatcher</td>
<td>0.5 seconds - 2 minutes</td>
</tr>
<tr>
<td>Messages</td>
<td>0 seconds - 80 seconds</td>
</tr>
<tr>
<td>Compile Send</td>
<td>1 minute - 2.5 minutes</td>
</tr>
</tbody>
</table>
Processing Time for BNAs [email]

Finishes in 3 minutes
Processing Time for BNAs [push]

Finishes in 2.5 minutes
Considerations

- Availability
- Observability
- Agility
- Extensibility
- Throughput
- Scalability
- Cost

GKE?
The New Messaging Platform enables us to

✓ Target our readers either by email or push notification
✓ Have a consolidated view of how we communicate with our readers.
✓ Segment our audience in different ways as we can now join with other tables in BigQuery
✓ A/B test campaigns easily
✓ Pave the way for personalized push notification messages
Thank you! Questions?

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