Gmail: Past, Present, and Future

Adam de Boor, Google

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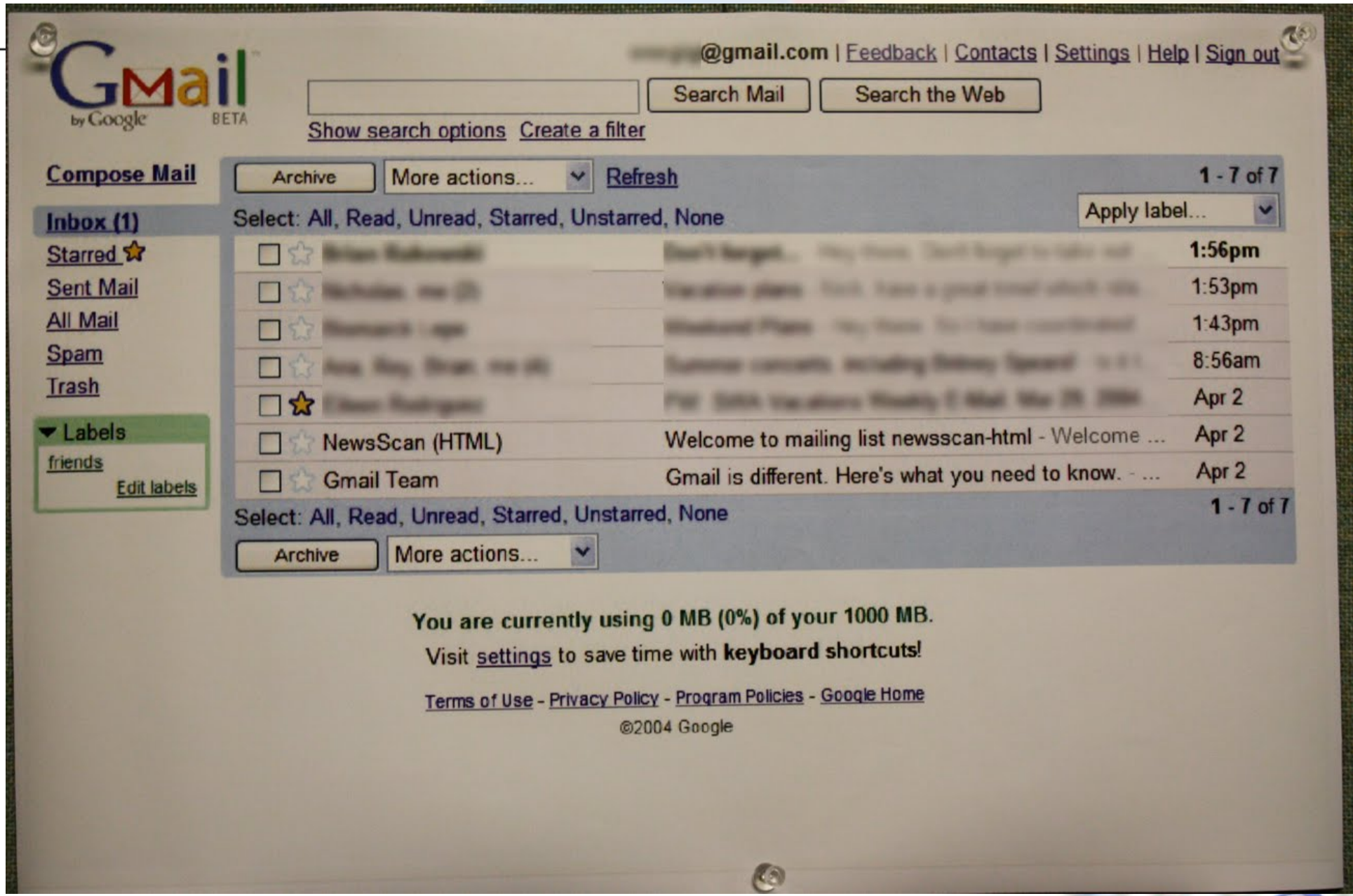
The Plan

Where we came from
Where we're at
What we've learned
Where we're going

Where We Came From



Where We Came From - 2004

April 1, 2004

- Slick webmail app using AJAX
- Plain-text compose
- 9400 lines of JS, downloaded as a block, in a frame
- JS compiler:
  - Condense code
  - Catch references to unknown vars
  - Verify function arity
  - Interpolate constants
  - Remove dead code
- No use of object classes
- HTML constructed as 'str' + var + 'str'
- Uses iframes for different views (switched)
- CSS in created STYLE elements

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Where We Came From - 2005

April 1, 2005

- Added "web 1.0" HTML interface
- Rich formatting in compose
- Now 22,000 lines of JS (+ 10,000 lines of comments)
  - Still one download
- 12 non-US languages
  - JS compiler used to find and replace messages
- JS compiler now also inlines functions

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Where We Came From - 2006

- Chat launched in February
- 52,000 lines of JS (75,000 with comments)
  - 4 modules - main broken into blocks
  - Classes
  - Start of Closure library
- 30 languages
- CSS still generated in JS
- Code base getting unwieldy
  - Combinations exploding
  - JS compiler looks for "frequently wrong" patterns

Where We Came From - 2007

- Rewrite! (shipped in October)
  - Make code base manageable (object classes!)
  - Speed
- 90,000 lines of JS (187,000 with comments) in 31 modules + libraries
- New module system
  - Dependency graph
  - Mods
- Closure Templates
  - Way easier than string concatenation
  - Automatic escaping
- Macro processing of CSS, served from server
- Simple type checking in JS compiler + optimizations

Where We Came From - 2008

- Innovation speed increased
  - Gmail Labs
  - Themes
  - New feature launched / week
- JS Compiler: better type checking, type-based code stripping, more optimizations
- 190k lines of JS (403k with comments)

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Where We Came From - 2009

- Out of beta
- Offline using Google Gears
- JS Compiler: data-flow analysis, more checks, move functions/methods between modules
- 279k lines of JS (610k with comments)
- Released Closure library, compiler, and templates
- Released Open GSE

Where We Are

- More than just mail:
  - Google Buzz now in Gmail
  - Video and voice chat
  - SMS
  - Extensible through Google Apps Marketplace
- 60+ active labs
- 443k lines of JS (978k with comments)
- *Really complex application*

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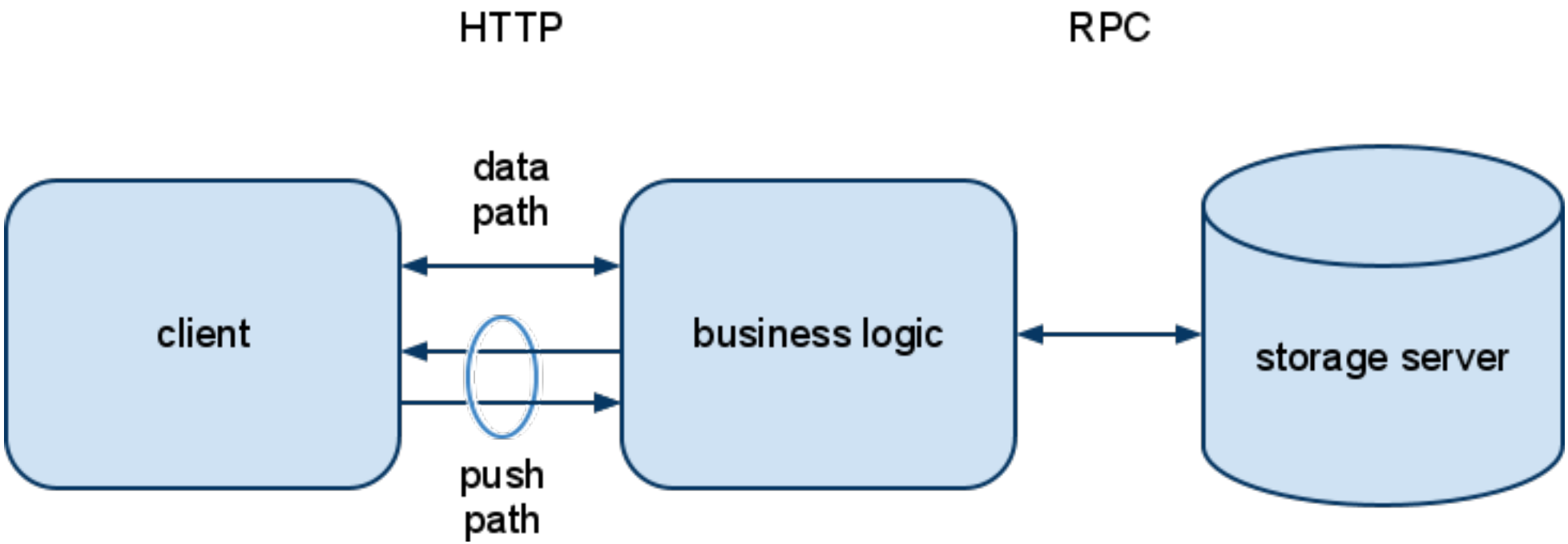
Macro-architecture



data path: code, styles, preferences, user data, ...
push path: chat, new mail, presence, contact updates, buzz updates, ...

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Client

- Builds all UI
- Loads code when needed
- Fetches and caches data
- Records actions for performance analysis
- Reports presence / idle
- Gadget container
- Drives multiple windows

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Server

- Routes / translates between client and 10+ backend servers
  - Talk, contacts, search, spell-check, translate, antivirus, SMTP in, SMTP out, authentication, ...
- Compiles and serves JS
- Compiles and serves themes as encoded stylesheet
- Incoming mail processing
- Synchronization for offline support

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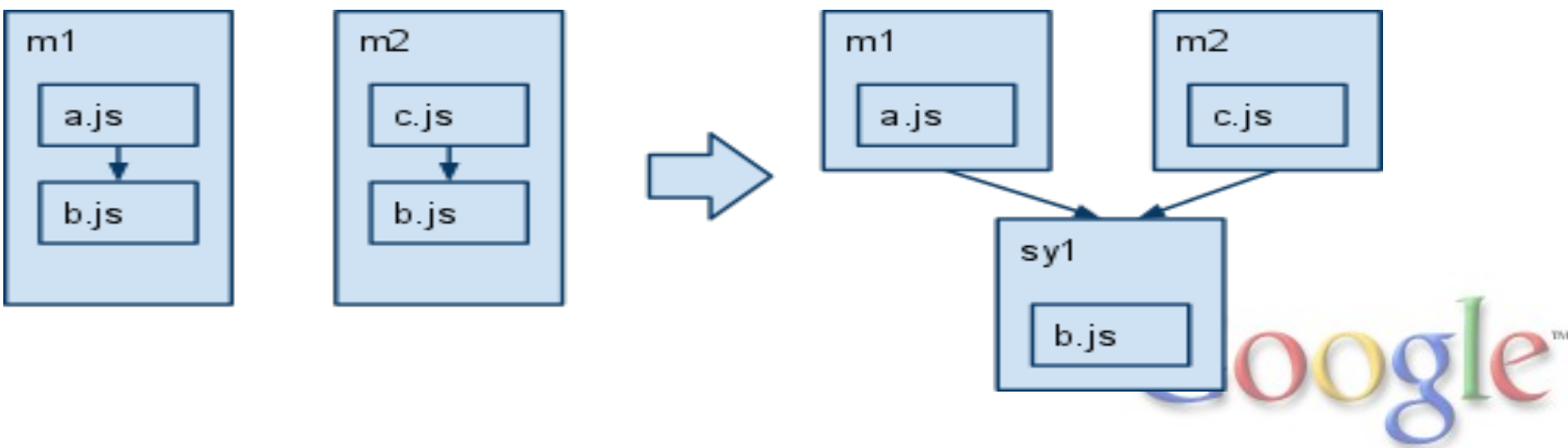
Client Details - Modules

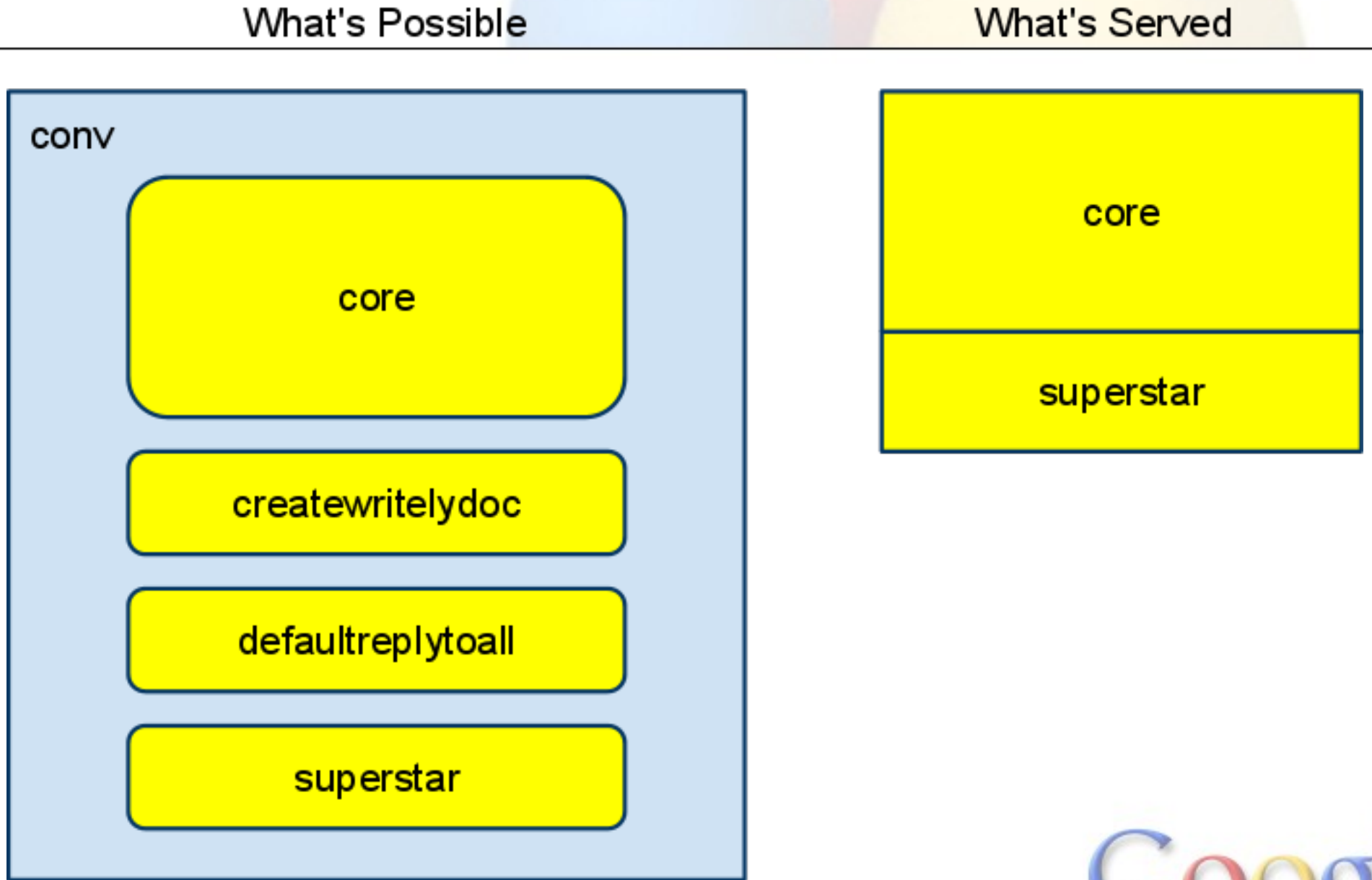
- Modules based on entry points
  - Particular services (e.g. mole manager, chat)
  - Particular views (thread list, conversation, etc.)
- Non-entry-point code assigned to modules automatically
  - Files say what classes they require and provide
  - Classes needed multiple places => synthesized modules



Client Details - Mods

- Mods enable tailored code w/o storage explosion
  - Mod = named code segments enabled per-user
  - Appended to module if enabled
  - Tweaks base code
- Whole app compiled / optimized, then fragmented
- Modules assembled from fragments based on enabled mods

Module/Mod Example



Themes

- Mostly colors / images (can be radical)
- Macro processing of stylesheets
  - Everything skinnable is a macro
  - Last definition wins
- Start with basic color palette definitions
- Define attributes of all components in those terms
- Theme can tweak base palette or components
  - Theme definition is last file in the compilation

Services / Components

- Named services with defined interfaces
- Service objects registered in registry tree
  - Root registry for entire app
  - Child registry for each window
  - Failed lookup in child is repeated in parent
- Service object can be late-loaded
  - Callback when service defined, or error
- Components re-usable in alternate environments
- Replaceable for tests, alternate environments, alternate look&feel

Latency Tracking and Alerts

- All user actions timed, including server time
- Timing data uploaded to server and gathered
- Graphable along many axes
  - Country, Browser, Operation, Release, ...
  - Local, Server, Queue-delay, ...
  - Median, Mean, 25th pctl, 90th ptcl, ...
- Automated system predicts timing and count along many axes and alerts if the world is different

Test Automation

- Unit tests with system akin to JSUnit
  - Compiled and uncompiled
- Some tests in Selenium
- In-application UI tests
  - Simpler for developers to write
  - Isolated in module and mod
  - Still can't generate real mouse events
- Use automation suite to gauge latency impact of a change or feature
- Multiple continuous builds test all aspects of client and server

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What We've Learned

- Type-checking is important and possible
- Instrument everything
- Codify learnings in sanity tests & compiler warnings
  - .manager-page .searchbar span{color:#000}
  - .CSS_IMG_DIV:hover .CSS_PLAY_DIV {opacity: 1;}
- Testing is vital

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Where We're Going

- HTML5
  - Change to leverage CSS3 reduced DOM by 30% and initial load time by 12%
  - Attachment / image drag-in
  - AppCache
  - Database
- Moving the platform forward
  - Dragging files out
  - Magic IFRAME
  - Installable apps with persistent background page

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Drag Out

- Leverage drag-and-drop from HTML5
- Add new data transfer format: DownloadURL
  - String of form *mime-type*:*name*:*url*
- On drop, browser downloads file and streams it to drop target, marked as insecure

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Magic IFRAME

- Targeted at apps with multiple windows
- All code and data go into an IFRAME
- If window hosting the IFRAME unloads, it gets adopted by another of the windows
- In Gmail for example:
  - Tearoff / pop-out compose creates bare window that is filled by code in IFRAME in main window
  - If you close the main window, the code looks for a tearoff that can accept the IFRAME and moves it
  - You finish your compose and can still send the email
- Old way: create new instance of Gmail tailored to the task.

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Apps with Background Window

- User installs web app => greater trust
- App opens background page that is always loaded
- App defines domain extent that puts pages in same process
- Page loaded from web can find background window
- In Gmail:
  - Background page holds all code and data
  - Background code fills in DOM of foreground page
  - Background keeps data up-to-date
  - Really fast startup

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Questions?