Commute Compute System™

Complete Project Overview

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By Angus Bergman

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Version: 1.0 **Date:** January 2026 **Author:** Angus Bergman **License:** CC BY-NC 4.0

Part 1: Vision & Goals

What is Commute Compute?

Commute Compute System™ is a fully self-hosted smart transit display for Australian public transport. It delivers real-time journey information to beautiful e-ink displays, helping commuters know exactly when to leave — including whether there's time for coffee.

The Problem We Solve

Every morning, commuters face the same questions: - "When should I leave?" - "Is my train delayed?" - "Do I have time for coffee?" - "Should I bring an umbrella?"

Commute Compute answers all of these at a glance on a dedicated e-ink display.

Core Principles

PrincipleWhat It Means |

| **Privacy First**Your data stays on YOUR server. No tracking, no analytics. **Truly Free**Runs on Vercel free tier. No subscriptions or hidden costs. **Zero Dependencies**Custom firmware connects only to your server — not to any cloud. **Australian Focus**Built for Australian transit: VIC, NSW, QLD supported. **Open Source**All code freely available under CC BY-NC 4.0.

Brand Architecture

BrandPurpose |

| **Commute Compute System™** Overall system name **SmartCommute™** Journey calculation engine **CCDash™** Dashboard rendering specification (V10) **CC LiveDash™** Multi-device live renderer **CCFirm™** Custom firmware family

Target Users

Primary: Australian Capital City Commuters

- Daily train/tram/bus commuters in Melbourne, Sydney, Brisbane - Want to optimize their morning routine - Value knowing exactly when to leave - Appreciate the "coffee time" calculation

Secondary: Smart Home Enthusiasts

- E-ink display hobbyists - Open-source contributors - IoT experimenters

Part 2: System Architecture

Self-Hosted Distribution Model

Every user deploys their own complete stack. There is no central server.

`` ┌──┐ │ YOUR DEPLOYMENT │ │ │ │ GitHub Fork Your Server Your Device │ │ ┌─────────┐ ┌─────────┐ ┌─────────┐ │ │ │ Your Copy │ Deploy │ Vercel │ Image │ TRMNL │ │ │ │ of Repo │ ───────▶ │ (Free) │ ───────▶ │ E-ink │ │ │ └─────────┘ └─────────┘ └─────────┘ │ │ │ │ │ │ Config Token in URL ◀─────────────┘ │ │ (API keys embedded) │ │ │ │ □ Complete data isolation between users │ │ □ Zero-config — no environment variables to edit │ │ □ No central server dependency │ └──┘ `

`Why Self-Hosted?`

1. **Privacy**: Your commute patterns never leave your server 2. **Reliability**: No single point of failure 3. **Cost**: Vercel free tier is sufficient 4. **Control**: You own everything

`Technology Stack`

`LayerTechnology |`

|

| **Server**Node.js 18+, Vercel Serverless **Rendering**@napi-rs/canvas, 1-bit BMP generation **Transit Data**GTFS-RT (VIC, NSW, QLD) **Weather**Bureau of Meteorology **Firmware**ESP32-C3, PlatformIO, C++ **Display**E-ink 800×480 (TRMNL), various Kindle

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Data Flow

` ┌──────────────────────┐ │ Transit Authority │ (Transport Victoria, TfNSW, TransLink) │ GTFS-RT Feeds │ └──────────┬───────────┘ │ ▼ 30s cache ┌──────────────────────┐ │ SmartCommute™ │ ← Journey calculation engine │ Engine │ └──────────┬───────────┘ │ ┌─────┴──────┬──────────────┐ │ │ │ ▼ ▼ ▼ ┌──────────┐ ┌──────────┐ ┌──────────────┐ │ Weather │ │ Coffee │ │ Disruption │ │ (BOM) │ │Decision │ │ Detection │ └────┬─────┘ └────┬─────┘ └──────┬───────┘ │ │ │ └────────────┼──────────────┘ │ ▼ ┌──┐ │ CCDash™ V10 Renderer │ │ Creates 800×480 1-bit BMP image │ └───────────────────┬──────────────────────┘ │ ▼ ┌──┐ │ Your E-ink Device │ │ Displays image, sleeps 20 seconds │ └──┘ `

Supported Devices

TRMNL E-ink Displays (Primary)

```
DeviceResolutionStatus |
```

|

|

| **TRMNL OG**800×480□ Primary target **TRMNL Mini**400×300□ Supported

Kindle E-readers (Jailbreak Required)

DeviceResolutionStatus |

|

|

| Kindle Paperwhite 51236×1648□ Supported Kindle Paperwhite 3/41072×1448□ Supported Kindle Voyage1072×1448□ Supported

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Supported Transit Systems

StateAuthorityStatus |

|

|

| **Victoria**Transport Victoria (PTV)□ Production **NSW**Transport for NSW□ Supported **Queensland**TransLink□ Supported South AustraliaAdelaide Metro□ Planned Western AustraliaTransperth□ Planned

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Part 3: The SmartCommute™ Engine

How It Works

The SmartCommute™ engine is the brain of Commute Compute. It calculates optimal journeys by:

1. **Fetching real-time data** from transit authorities (GTFS-RT) 2. **Detecting delays and disruptions** from service alerts 3. **Calculating multi-modal routes** (walk → tram → train → walk) 4. **Inserting coffee stops** when timing permits 5. **Adapting to disruptions** with alternative routes

Key Capabilities

FeatureDescription |

|

| **Real-time delays**Shows actual delay in minutes (+5 MIN, +10 MIN) **Service alerts**Detects suspensions, diversions, cancellations **Coffee decision**Calculates if you have time for coffee **Multi-modal**Combines walk, train, tram, bus seamlessly **Express detection**Identifies express services that save time **Weather integration**Shows temperature and umbrella recommendation

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CoffeeDecision Logic

The engine determines whether to include a coffee stop based on:

1. **Is coffee enabled?** (user preference) 2. **Is the cafe open?** (cached business hours) 3. **Will we still arrive on time?** (with coffee duration added) 4. **Should we skip due to delays?** (smart skip when running late)

Coffee Patterns

PatternDescription |

|

| **Origin**Coffee before leaving (near home) **Interchange**Coffee at a transfer point **Destination**Coffee near work **Skip**No coffee when running late

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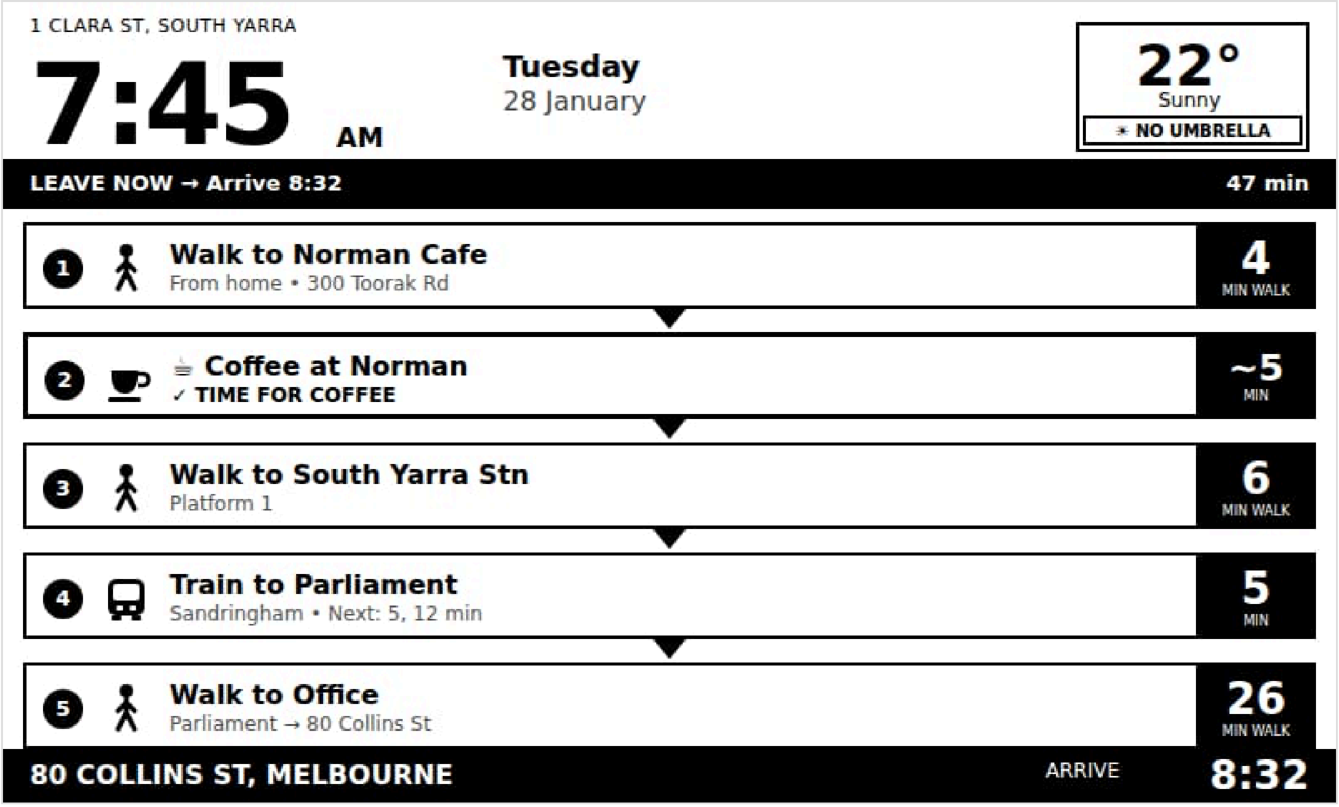
Part 4: Dashboard Scenarios

The following images demonstrate how the SmartCommute™ engine handles various real-world scenarios. Each dashboard is rendered server-side and delivered to the e-ink display.

Scenario 1: Normal Morning Commute with Coffee



1 CLARA ST, SOUTH YARRA

7:45 AM

Tuesday
28 January

22°
Sunny
☀ NO UMBRELLA

LEAVE NOW → Arrive 8:32 47 min

1 Walk to Norman Cafe
From home • 300 Toorak Rd
4 MIN WALK

2 ☕ Coffee at Norman
✓ TIME FOR COFFEE
~5 MIN

3 Walk to South Yarra Stn
Platform 1
6 MIN WALK

4 Train to Parliament
Sandringham • Next: 5, 12 min
5 MIN

5 Walk to Office
Parliament → 80 Collins St
26 MIN WALK

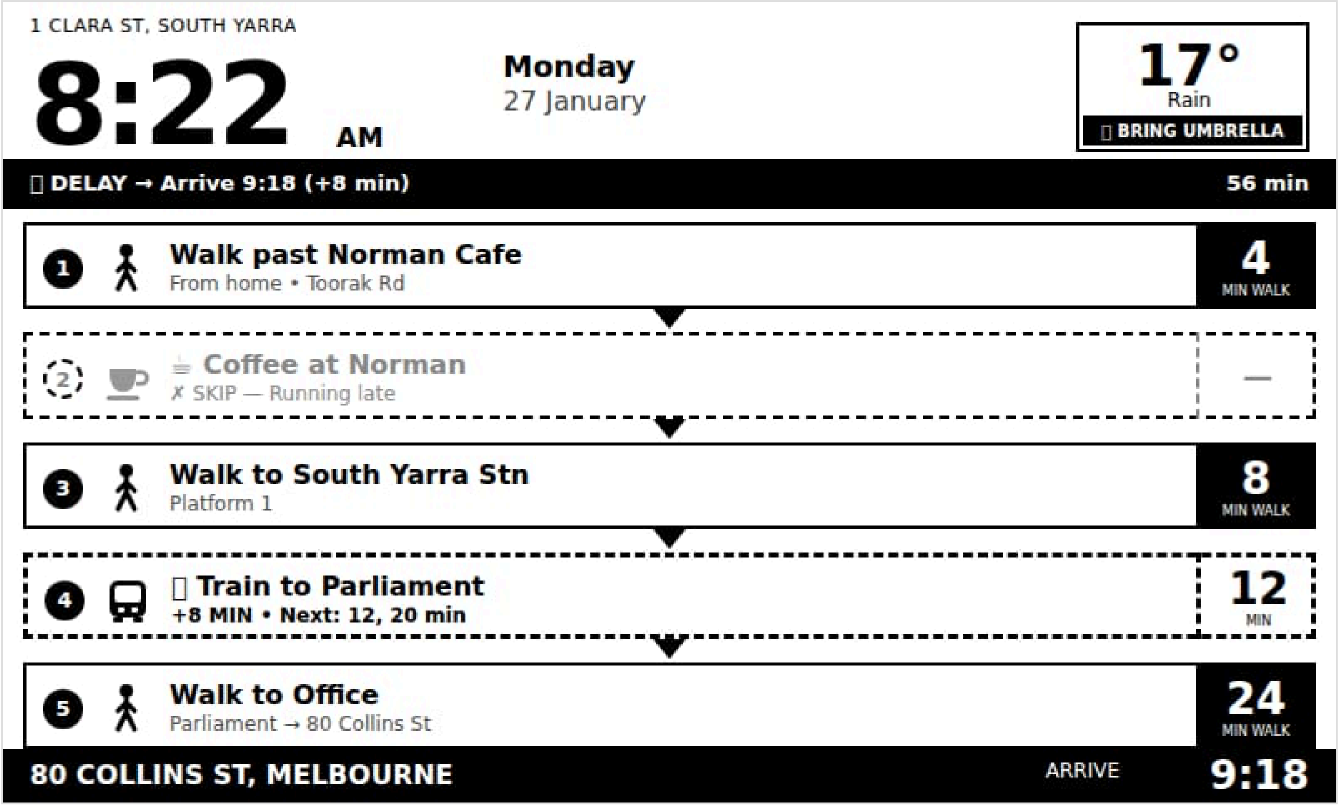
80 COLLINS ST, MELBOURNE ARRIVE 8:32

Location: 1 Clara St, South Yarra **Time:** 7:45 AM Tuesday **Weather:** 22° Sunny, NO UMBRELLA

What the engine calculated: - Total journey: 47 minutes to arrive at 8:32 - □ "TIME FOR COFFEE" — enough buffer to stop at Norman Cafe - 5-leg journey: Walk → Coffee → Walk → Train → Walk - Coffee duration shown as ~5 min (approximate)

Visual elements: - Solid borders = normal service - Coffee icon with checkmark = time confirmed - Green status bar = "LEAVE NOW"

Scenario 2: Delay with Coffee Skip



1 CLARA ST, SOUTH YARRA

8:22 AM

Monday
27 January

17°
Rain
▯ BRING UMBRELLA

▯ DELAY → Arrive 9:18 (+8 min)   56 min

1 Walk past Norman Cafe
From home • Toorak Rd
4 MIN WALK

2 ☕ Coffee at Norman
✗ SKIP — Running late
—

3 Walk to South Yarra Stn
Platform 1
8 MIN WALK

4 ▯ Train to Parliament
+8 MIN • Next: 12, 20 min
12 MIN

5 Walk to Office
Parliament → 80 Collins St
24 MIN WALK

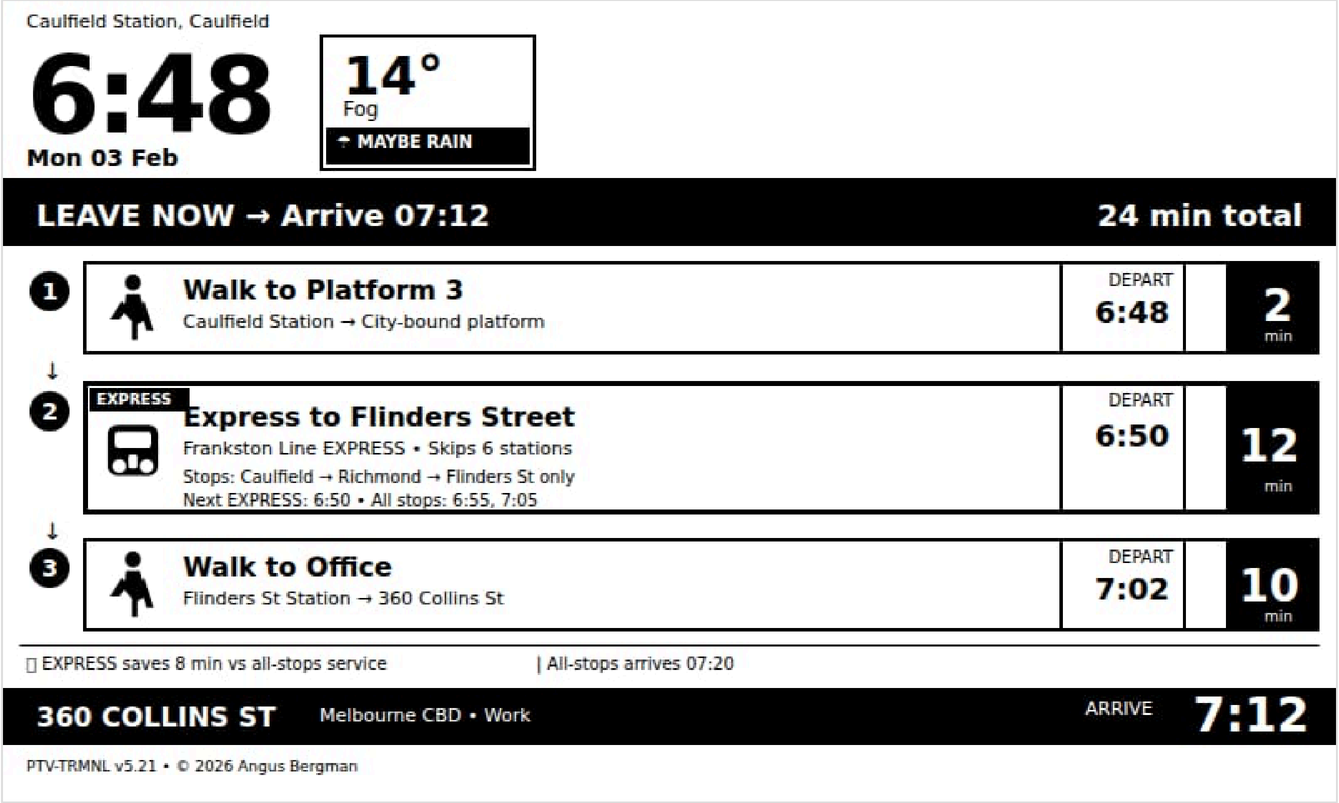
80 COLLINS ST, MELBOURNE   ARRIVE 9:18

Location: 1 Clara St, South Yarra **Time:** 8:22 AM Monday **Weather:** 17° Rain, BRING UMBRELLA

What the engine calculated: - Train is delayed +8 minutes - Arrival pushed to 9:18 (+8 min late) - ⚠ Coffee SKIPPED — "Running late" - Engine automatically removed coffee to minimize delay

Visual elements: - Dashed border on coffee leg = SKIP state - "✗ SKIP — Running late" status text - Dashed border on train = delayed service - Status bar shows "DELAY → Arrive 9:18 (+8 min)"

Scenario 3: Express Service Detection



Caulfield Station, Caulfield

6:48

Mon 03 Feb

14°

Fog

☂ MAYBE RAIN

LEAVE NOW → Arrive 07:12 24 min total

1 Walk to Platform 3
Caulfield Station → City-bound platform
DEPART 6:48 | 2 min

2 EXPRESS
Express to Flinders Street
Frankston Line EXPRESS • Skips 6 stations
Stops: Caulfield → Richmond → Flinders St only
Next EXPRESS: 6:50 • All stops: 6:55, 7:05
DEPART 6:50 | 12 min

3 Walk to Office
Flinders St Station → 360 Collins St
DEPART 7:02 | 10 min

▯ EXPRESS saves 8 min vs all-stops service | All-stops arrives 07:20

360 COLLINS ST Melbourne CBD • Work ARRIVE 7:12

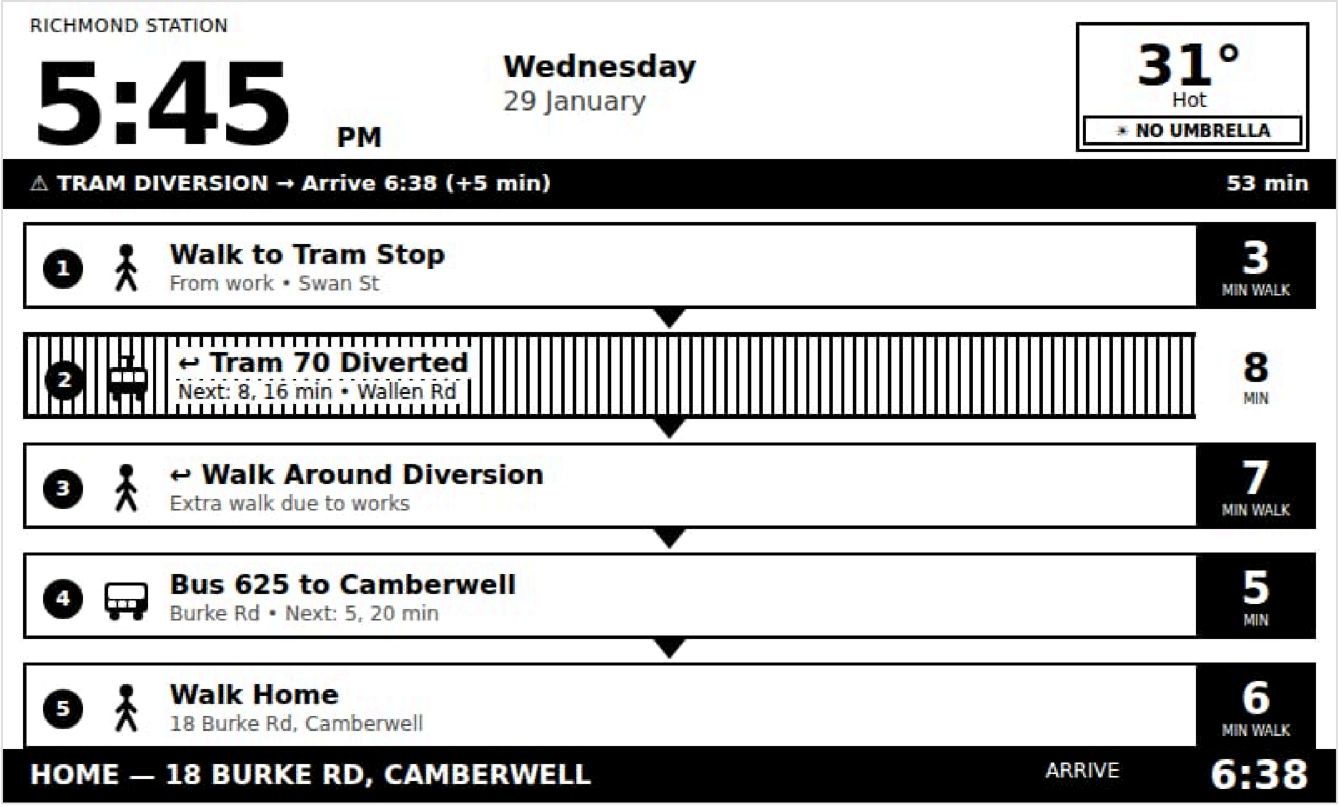
PTV-TRMNL v5.21 • © 2026 Angus Bergman

Location: Caulfield Station **Time:** 6:48 AM Monday **Weather:** 14° Fog, MAYBE RAIN

What the engine calculated: - Detected EXPRESS service on Frankston Line - Express skips 6 stations (Caulfield → Richmond → Flinders St only) - Shows time savings: "EXPRESS saves 8 min vs all-stops service" - Next all-stops service also shown for reference

Visual elements: - "EXPRESS" badge on service - Detailed stop information - Footer note comparing express vs all-stops - Alternative departure times shown

Scenario 4: Tram Diversion



RICHMOND STATION

5:45 PM

Wednesday
29 January

31°
Hot
☀ NO UMBRELLA

⚠ TRAM DIVERSION → Arrive 6:38 (+5 min) 53 min

1 Walk to Tram Stop
From work • Swan St
3 MIN WALK

2 ↩ Tram 70 Diverted
Next: 8, 16 min • Wallen Rd
8 MIN

3 ↩ Walk Around Diversion
Extra walk due to works
7 MIN WALK

4 Bus 625 to Camberwell
Burke Rd • Next: 5, 20 min
5 MIN

5 Walk Home
18 Burke Rd, Camberwell
6 MIN WALK

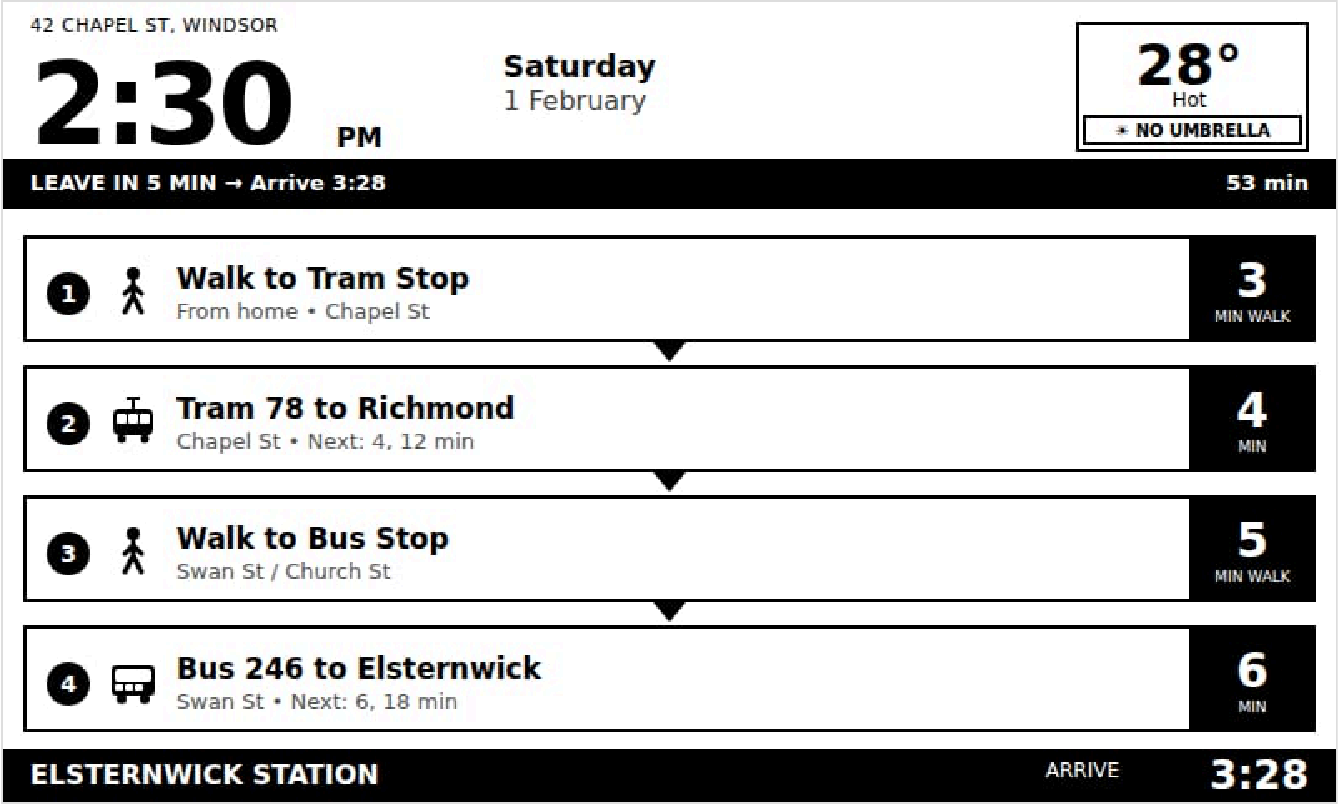
HOME — 18 BURKE RD, CAMBERWELL ARRIVE 6:38

Location: Richmond Station **Time:** 5:45 PM Wednesday **Weather:** 31° Hot, NO UMBRELLA

What the engine calculated: - Tram 70 is diverted due to works - Route adapted: Tram (partial) → Walk around diversion → Bus - Total journey extended to 53 minutes - Status shows "TRAM DIVERSION → Arrive 6:38 (+5 min)"

Visual elements: - "← Tram 70 Diverted" with arrow indicating diversion - "← Walk Around Diversion" extra walking leg added - Dashed borders on affected legs - Bus replacement shown as alternative

Scenario 5: Multi-Modal Journey (Tram + Bus)



42 CHAPEL ST, WINDSOR

2:30 PM

Saturday
1 February

28°
Hot
☀ NO UMBRELLA

LEAVE IN 5 MIN → Arrive 3:28 53 min

1 Walk to Tram Stop
From home • Chapel St
3 MIN WALK

2 Tram 78 to Richmond
Chapel St • Next: 4, 12 min
4 MIN

3 Walk to Bus Stop
Swan St / Church St
5 MIN WALK

4 Bus 246 to Elsternwick
Swan St • Next: 6, 18 min
6 MIN

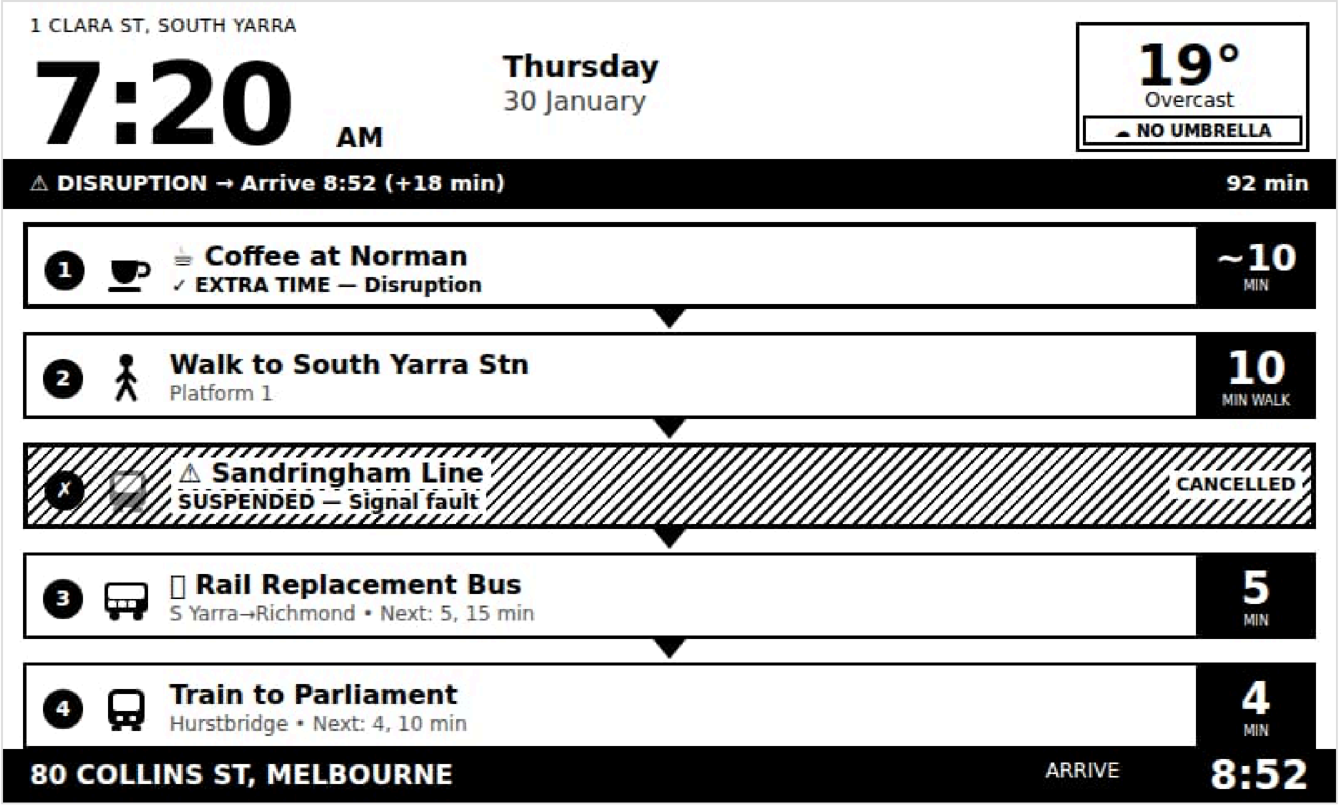
ELSTERNWICK STATION ARRIVE 3:28

Location: 42 Chapel St, Windsor **Time:** 2:30 PM Saturday **Weather:** 28° Hot, NO UMBRELLA

What the engine calculated: - Journey requires tram then bus connection - Tram 78 to Richmond, then Bus 246 to Elsternwick - Walking segments between modes - Total: 53 minutes, arrive 3:28

Visual elements: - Different icons for each mode (tram vs bus) - Transfer walks clearly shown - "Next: 4, 12 min" shows upcoming service frequency

Scenario 6: Major Disruption with Rail Replacement



1 CLARA ST, SOUTH YARRA

7:20 AM

Thursday
30 January

19°
Overcast
☂ NO UMBRELLA

⚠ DISRUPTION → Arrive 8:52 (+18 min) 92 min

1	☕ Coffee at Norman ✓ EXTRA TIME — Disruption	~10 MIN
2	Walk to South Yarra Stn Platform 1	10 MIN WALK
✗	⚠ Sandringham Line SUSPENDED — Signal fault	CANCELLED
3	▯ Rail Replacement Bus S Yarra→Richmond • Next: 5, 15 min	5 MIN
4	Train to Parliament Hurstbridge • Next: 4, 10 min	4 MIN

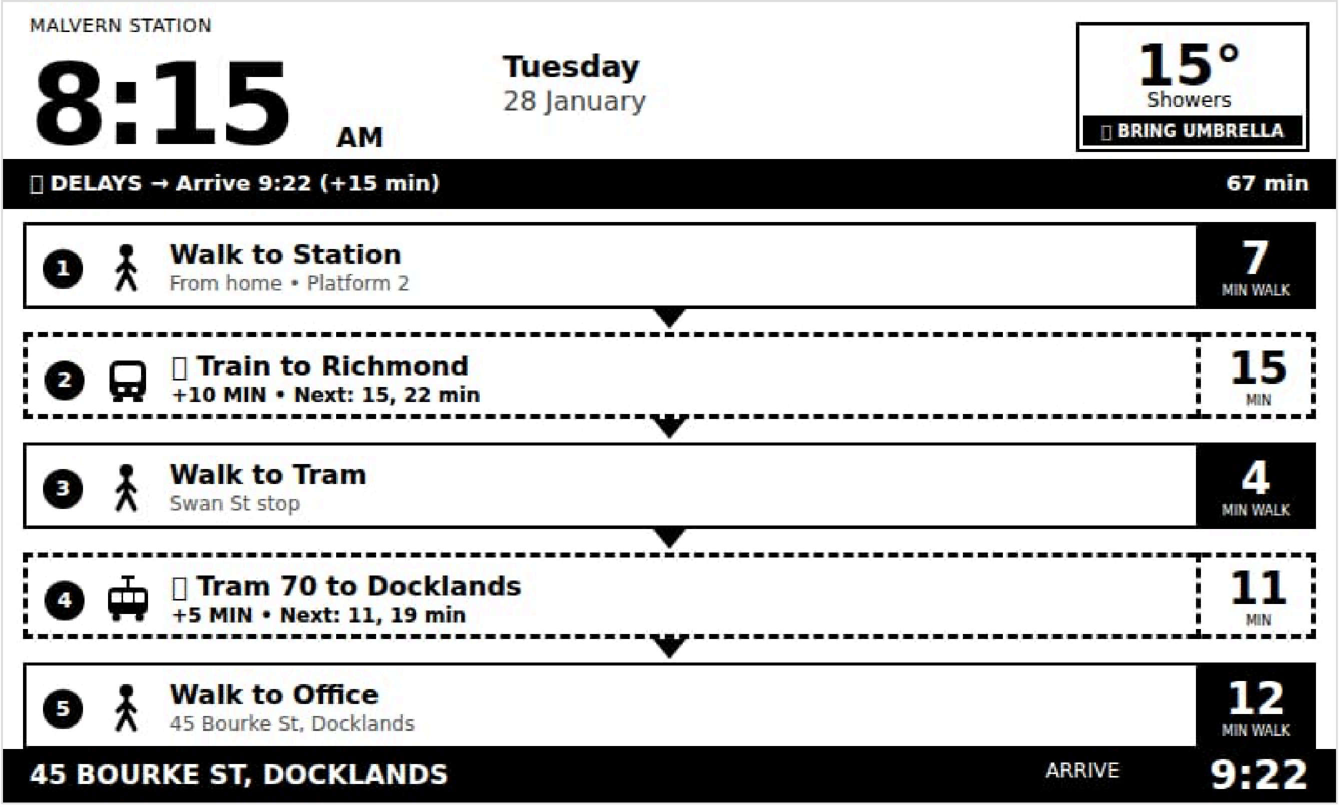
80 COLLINS ST, MELBOURNE ARRIVE 8:52

Location: 1 Clara St, South Yarra **Time:** 7:20 AM Thursday **Weather:** 19° Overcast, NO UMBRELLA

What the engine calculated: - Sandringham Line SUSPENDED (signal fault) - Rail replacement bus inserted automatically - Journey rerouted: Bus → Richmond → Train - Extra time available → coffee added ("EXTRA TIME — Disruption") - Total delay: +18 minutes

Visual elements: - Diagonal stripe pattern = CANCELLED/SUSPENDED - "CANCELLED" text on affected service - "⚠ Sandringham Line SUSPENDED — Signal fault" - Rail Replacement Bus leg automatically inserted - Status: "DISRUPTION → Arrive 8:52 (+18 min)"

Scenario 7: Multiple Delays



MALVERN STATION

8:15 AM

Tuesday
28 January

15°
Showers
□ BRING UMBRELLA

□ DELAYS → Arrive 9:22 (+15 min) 67 min

1 Walk to Station
From home • Platform 2
7 MIN WALK

2 □ Train to Richmond
+10 MIN • Next: 15, 22 min
15 MIN

3 Walk to Tram
Swan St stop
4 MIN WALK

4 □ Tram 70 to Docklands
+5 MIN • Next: 11, 19 min
11 MIN

5 Walk to Office
45 Bourke St, Docklands
12 MIN WALK

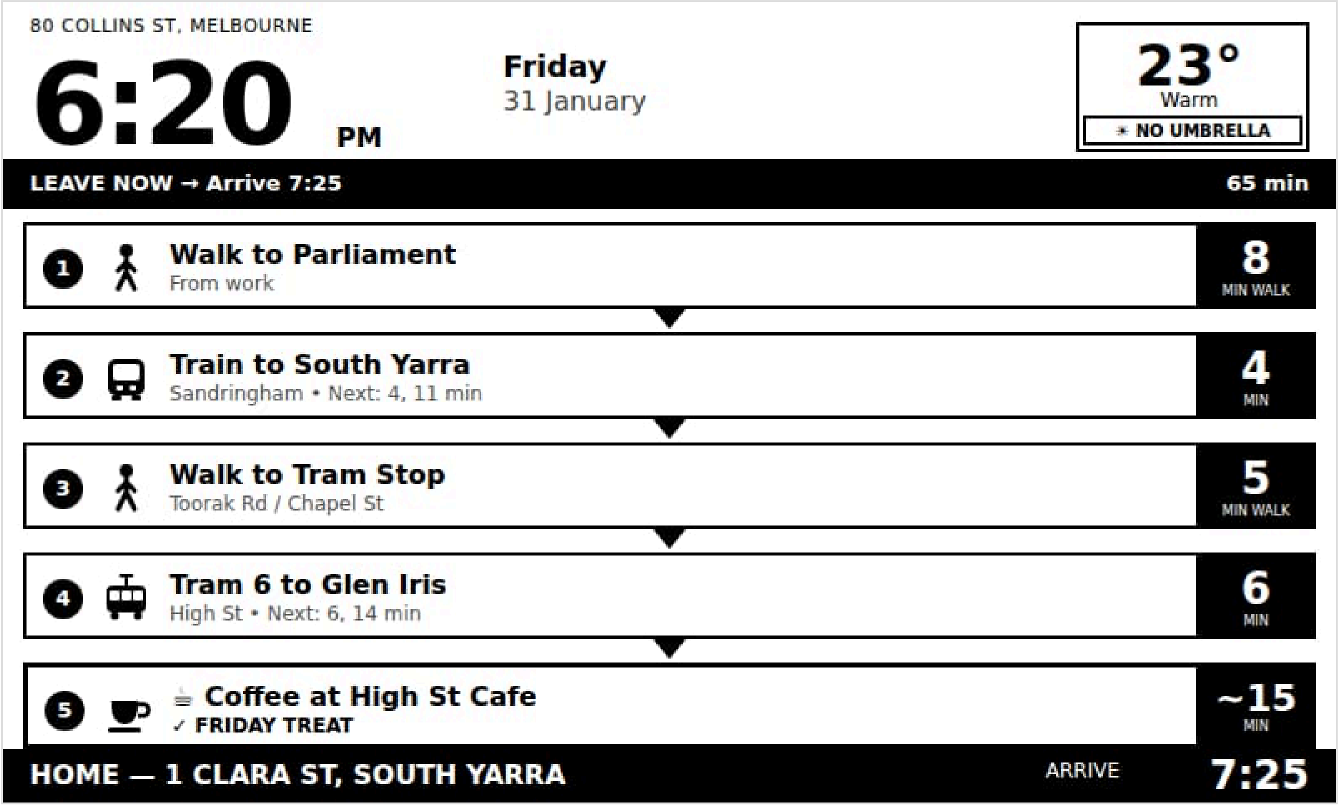
45 BOURKE ST, DOCKLANDS ARRIVE 9:22

Location: Malvern Station **Time:** 8:15 AM Tuesday **Weather:** 15° Showers, BRING UMBRELLA

What the engine calculated: - Train to Richmond delayed +10 minutes - Tram 70 to Docklands delayed +5 minutes - Combined delay: +15 minutes - Status shows "DELAYS" (plural)

Visual elements: - Multiple legs with dashed borders - "+10 MIN" and "+5 MIN" shown on respective legs - Status bar: "DELAYS → Arrive 9:22 (+15 min)"

Scenario 8: Evening Commute with Friday Treat



80 COLLINS ST, MELBOURNE

6:20 PM

Friday
31 January

23°
Warm
☀ NO UMBRELLA

LEAVE NOW → Arrive 7:25 65 min

1 Walk to Parliament
From work
8 MIN WALK

2 Train to South Yarra
Sandringham • Next: 4, 11 min
4 MIN

3 Walk to Tram Stop
Toorak Rd / Chapel St
5 MIN WALK

4 Tram 6 to Glen Iris
High St • Next: 6, 14 min
6 MIN

5 ☕ Coffee at High St Cafe
✓ FRIDAY TREAT
~15 MIN

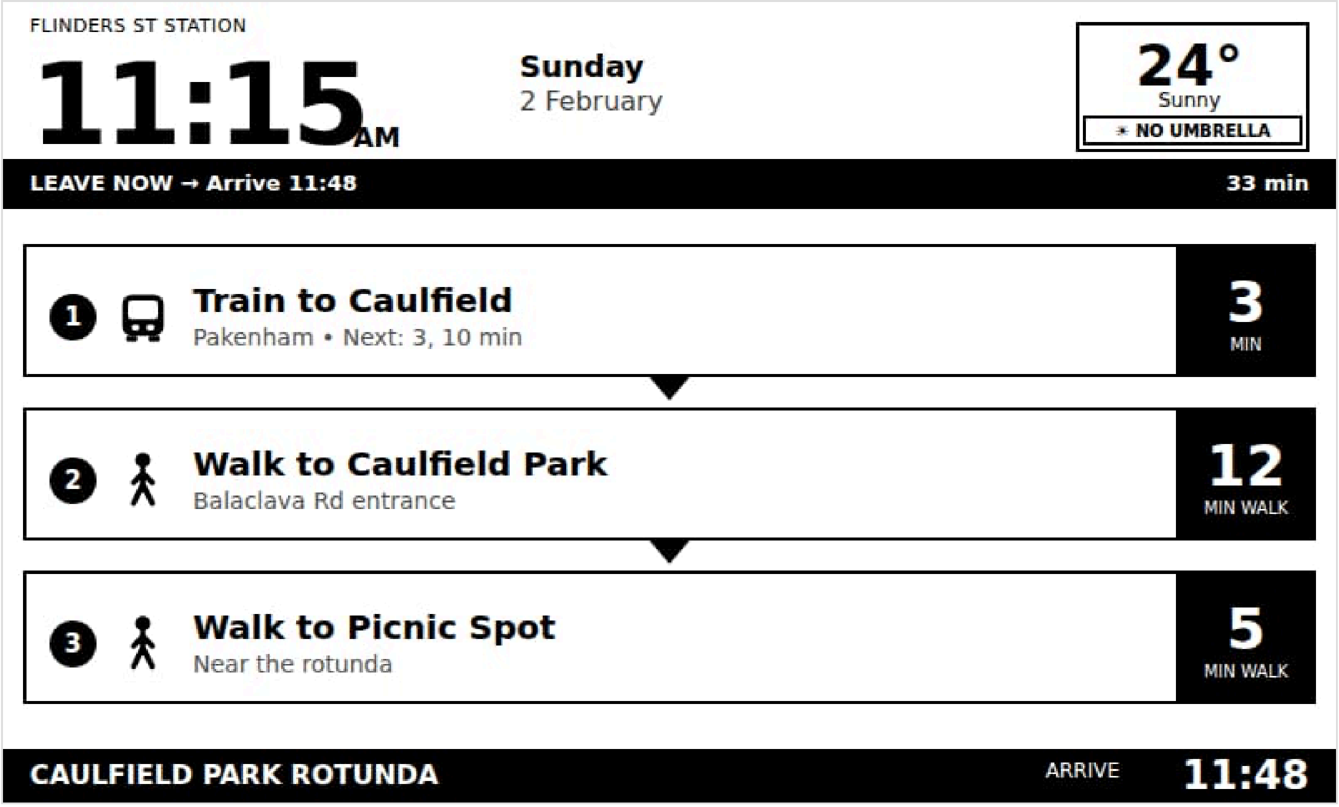
HOME — 1 CLARA ST, SOUTH YARRA ARRIVE 7:25

Location: 80 Collins St, Melbourne **Time:** 6:20 PM Friday **Weather:** 23° Warm, NO UMBRELLA

What the engine calculated: - Reverse commute (work → home) - Coffee at destination (High St Cafe, Glen Iris) - Special "FRIDAY TREAT" status for end-of-week coffee - 65 minute journey including coffee

Visual elements: - "✓ FRIDAY TREAT" — special end-of-week status - Coffee at end of journey (destination pattern) - Evening weather and warm temperature

Scenario 9: Weekend Leisure Trip



FLINDERS ST STATION

11:15 AM

Sunday
2 February

24°
Sunny
☀ NO UMBRELLA

LEAVE NOW → Arrive 11:48 33 min

1 Train to Caulfield
Pakenham • Next: 3, 10 min
3 MIN

2 Walk to Caulfield Park
Balaclava Rd entrance
12 MIN WALK

3 Walk to Picnic Spot
Near the rotunda
5 MIN WALK

CAULFIELD PARK ROTUNDA ARRIVE 11:48

Location: Flinders St Station **Time:** 11:15 AM Sunday **Weather:** 24° Sunny, NO UMBRELLA

What the engine calculated: - Non-work journey (leisure destination) - Simple route: Train → Walk to park → Walk to picnic spot - Destination: "Caulfield Park Rotunda" - 33 minutes total

Visual elements: - Different destination type (park, not work) - "Near the rotunda" descriptive text - Weekend date format - No coffee (leisure trip)

Part 5: Setup & Deployment

Zero-Config Architecture

Users never need to edit environment variables. All configuration happens through the Setup Wizard and is encoded into a URL token.

` SETUP (one-time) RUNTIME (automatic) ──────────────── ────────────────── 1. Enter addresses → All data cached in URL: 2. Geocode locations → • Home/work/cafe lat/lon 3. Select transit authority → • API keys 4. Enter preferences → • Coffee settings 5. Generate webhook URL → • State selection Device fetches from YOUR URL with embedded config. No server-side storage required. `

Free-Tier First

The entire system works on free infrastructure:

ServiceCostRequired |

`|`

`|`

`| Vercel HostingFREE□ Yes Transport Victoria APIFREE□ Yes BOM WeatherFREE□ Yes OpenStreetMap GeocodingFREEFallback Google PlacesPaid□ Optional`

Part 6: Technical Specifications

Dashboard Layout (CCDash™ V10)

```
` ┌──────────────────────────────────────────────────────────────┐ │ HEADER (0-94px)
│ │ [Location] [Time 64px] [AM/PM] [Day] [Weather] │
├──────────────────────────────────────────────────────────────┤ │ SUMMARY BAR (96-
124px) │ │ LEAVE NOW → Arrive 7:25 47min │
├──────────────────────────────────────────────────────────────┤ │ JOURNEY LEGS (132-
448px) │ │ ① □ Walk to Norman Cafe 4 MIN │ │ ▼ │ │ ② ☕ Coffee at Norman ~5 MIN │ │ ▼
│ │ ③ □ Walk to South Yarra Stn 6 MIN │ │ ▼ │ │ ④ □ Train to Parliament 5 MIN │ │ ▼
│ │ ⑤ □ Walk to Office 26 MIN │
├──────────────────────────────────────────────────────────────┤ │ FOOTER (448-480px) │
│ 80 COLLINS ST, MELBOURNE ARRIVE 8:32 │
└──────────────────────────────────────────────────────────────┘ `
```

Leg States

StateVisualWhen Used |

`|`

`|`

`| `**`Normal`**`Solid black borderService running normally `**`Delayed`**`Dashed border, "+X MIN"Service delayed `**`Skip`**`Dashed border, grayedCoffee skipped `**`Cancelled`**`Diagonal stripesService suspended `**`Diverted`**`Dashed + arrowRoute diverted`

Status Bar Variants

`StatusDisplay |`

`|`

`| Normal`LEAVE NOW → Arrive 8:32` Leave Soon`LEAVE IN 5 MIN → Arrive 8:32` Delay`□ DELAY → Arrive 8:40 (+8 min)` Delays`□ DELAYS → Arrive 8:45 (+13 min)` Disruption`⚠ DISRUPTION → Arrive 9:00 (+28 min)` Diversion`⚠ TRAM DIVERSION → Arrive 8:38 (+6 min)`

Part 7: Roadmap

Completed □

- Core server architecture - CCDash™ V10 specification - SmartCommute™ engine - CC LiveDash™ multi-device renderer - CCFirm™ custom firmware - Victoria, NSW, Queensland support - Setup Wizard with zero-config - Comprehensive documentation

In Progress □

- End-to-end testing - Additional device support - Polish and error handling

Planned □

- South Australia, Western Australia, Tasmania support - Inkplate and Waveshare device support - Video tutorials - Public launch

Summary

Commute Compute System™ is a privacy-respecting, fully self-hosted smart transit display that:

1. **Shows real-time departures** from Australian transit authorities 2. **Calculates optimal routes** across multiple transport modes 3. **Decides if you have time for coffee** based on your schedule 4. **Adapts to delays and disruptions** automatically 5. **Runs for free** on Vercel with no ongoing costs 6. **Protects your privacy** — your data never leaves your server

The project succeeds when a Melbourne commuter can glance at their e-ink display, see "LEAVE NOW — Coffee included", and walk out the door knowing they'll catch their train on time.

Built with ☕ in Melbourne