Identifying High Capacity Transit Corridors with the Emergent Network Modeling Framework

Presented by:
Dan Tischler

SAN FRANCISCO COUNTY TRANSPORTATION AUTHORITY
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Emergent Network Modeling Framework

- Method to find promising, not yet studied transit corridors
- Developed/used to support San Francisco’s Subway Vision
- Abstract transit network of seamless/ubiquitous subway
- Uses SF-CHAMP activity-based travel demand model
San Francisco Trends

- San Francisco growth
  - 2010 to 2015:
    + 60,000 people
    + 125,000 jobs
  - Regional forecasts for 2040
    + 200,000 more people
    + 250,000 more jobs
San Francisco Trends

▶ Transit conditions
  ▶ Rapid transit ridership growth (until recently)
  ▶ More crowded, slower, less reliable

▶ Upcoming completion of SF transit expansion project pipeline
  ▶ Central Subway
  ▶ Transbay Transit Center
  ▶ Van Ness BRT

https://www.bart.gov/about/planning/embarcadero-montgomery_capacity_implementation_plan

https://www.sfmta.com/projects-planning/projects/central-subway-project

http://transbaycenter.org
Subway Vision

- Subway Master Plan Ordinance
  - Passed by SF Board of Supervisors Nov 2015
  - Compels development of vision for subway expansion
  - Plan to be updated every four years

- Subway Vision
  - Explore possibilities for robust subway network in San Francisco
  - Outgrowth of existing transit-first policy
Subway Vision Forecasting Needs

► GOAL
► Look beyond corridors previously studied and impartially identify high potential corridors for further study

► NEEDS
► SF-CHAMP as modeling tool
► Agnostic to routes
► Agnostic to transit technology
► Agnostic to existing/planned transit service
► Consider regional connections
► Account for network effects
► Allow high demand routes to become apparent

► CONSTRAINT
► Time and money for just a few model runs
Standard Travel Forecasting Approach

- Run baseline scenario
- Run project scenario
  - Project definition
  - Detailed assumptions about routing, vehicles, speeds, frequencies, etc.
- Compare
  - Project scenario v. baseline scenario
  - Performance measures
“Why not put subways everywhere and see which routes are popular?”
Emergent Network Concept

Key concept
- Each link is a stand-alone subway line
- No penalty for transferring

Other design elements
- Links and stations at logical, but not necessarily realistic locations
- Remove background transit networks to remove noise
- Include regional connections as those represent fixed entry points
- Algorithmic process to select highest demand corridors
Emergent Network Design

- **Network rules**
  - **Travel time**
    - Max speed = 35 mph
    - Acceleration/deceleration = 3 mphs
    - Station dwell time = 30 s
  - **Transit service**
    - Seven car BART trainsets
    - Two minute headways
  - **Transfers**
    - Transfer walk time = None
    - Transfer wait time = None
    - Transfer penalty = None
High Demand Corridor Selection

1. Weight links by total ridership
2. Select the top-weighted subway link
3. Adjust weights for nearby links:
   1. Buffer x mi, find comparison links within the buffer
   2. Ignore connecting comparison links
   3. For each comparison link, reduce weight of the link as a function of the distance from both stations from the selected links’ stations:
      $$ W_{\text{new}} = W_{\text{old}} \times \left[ \frac{1}{2} (d_{a,a'}) + \frac{1}{2} (d_{b,b'}) \right] $$
      where,
      a is the first node of the selected link
      a' is the closest node to a in the comparison link
      b is the second node of the selected link
      b' is the closest node to b in the comparison link
      $dz,z'$ is the minimum of the distance between a and a', and 2
      $db,b'$ is the minimum of the distance between b and b', and 2
High Demand Corridor Selection

Example – Step 1 - Begin with loaded transit network
High Demand Corridor Selection

Example – Step 8 - Choose highest demand links, then discount parallel competing links
Model Results - Link Volumes

Subway Vision
Emergent Network 2040, New Transbay, Version 2
Predicted Ridership

Source: SF CHAMP 5.2-RC3_ev_JHC P2013 2040 Landuse
File Path: Q:\Model Projects\SubwayVision\2040_SV_NewTransbay_v2\Mapping
Model Results - Directionality

Emergent Network 2040, New Transbay, Version 3
Morning Peak-period Station Ons and Offs Breakdown

Station Ons and Offs Breakdown in AM

- 16,000
- Total Ons in AM
- Total Offs in AM

Subway Vision

Source: SF CHAMP 5.2-RC3_sw, JHC P2013 2040 Landuse
File Path: Q:\Model Projects\SubwayVision\2040_sw_NewTransbay_v3\Mapping
Model Results – Second Bay Crossing

Subway Vision
Emergent Network 2040
Predicted Ridership Comparison
Existing Transbay vs. New Transbay

Link Volume Decrease
From 1 TB to 3 TB

1

1,000

10

10,000

Link Volume Increase
From 1 TB to 3 TB

100

1

1,000

10

10,000

Source: SF CHAMP 5.2-RC3_av, JHC P2013 2040 Landuse
File Path: Q:\Model Projects\SubwayVision\2040_SV_ExistTransbay\Mapping
Role in Subway Vision

- Existing and future conditions assessment
- Emergent network modeling
- Public outreach

Network scenarios

Corridor evaluation
Emergent Network Modeling
Framework Assessment

- Transit paths genuinely intuitive, but
- Stop count mattered (station dwell), and affected assigned loads
- High demand corridor selection method not used
  - Difficult to make it work for non-grid network
  - Deemed unnecessary, we got what we needed without it
Recap

- Subway Vision project sought high potential transit corridors
- Emergent network modeling framework used to help identify transit alignments
  - Unrealistic, ubiquitous, go-anywhere transit network
  - Realistic routes, station spacing, link travel times
- Emergent network used in conjunction with public outreach and traditional needs assessment
- Useful toolbox component for long range visioning
Fin.
Thanks!
Questions?

Dan Tischler
dan.tischler@sfcta.org