

Sustainable Transit for China's Hypergrowth Cities

(a case study for the city of Chengdu)



By Michael Cassidy & Yuwei Li
University of California, Berkeley
Institute of Transportation Studies

Presentation “Road Map”

1. Some statistics in China

- (i) economic & population growth in cities
- (ii) growth in auto ownership & use!!
- (iii) governmental responses

2. Berkeley’s collaborative efforts

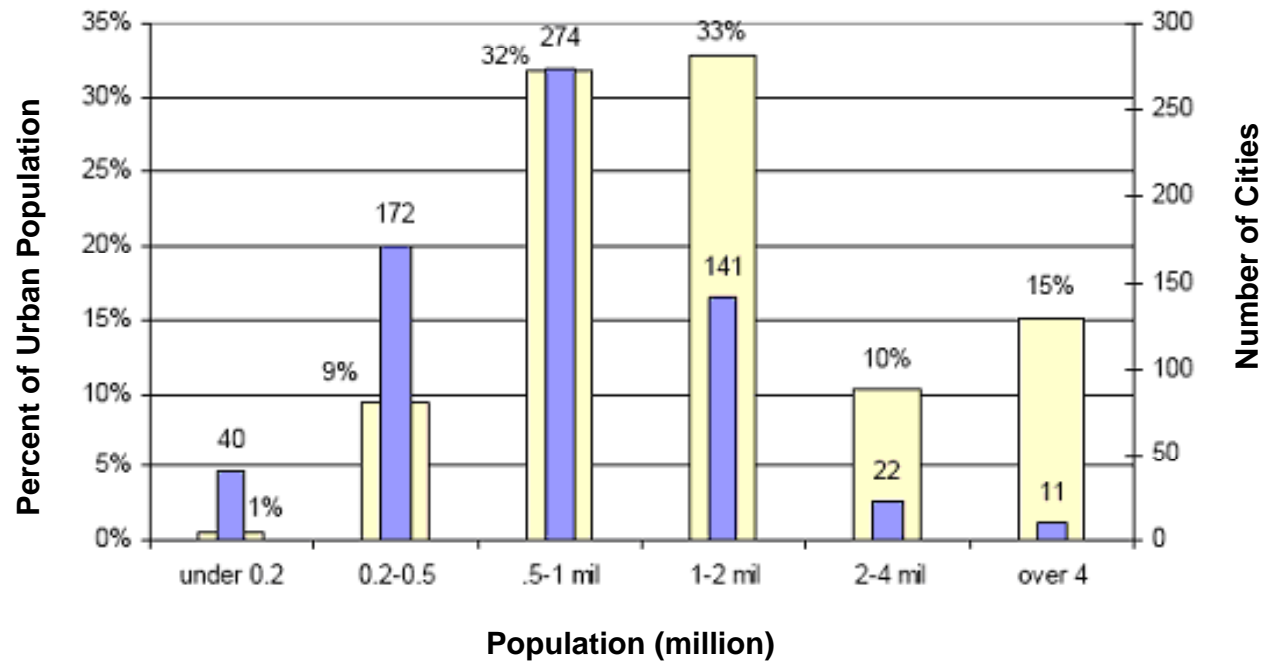
- (i) design of feeder bus network
- (ii) Bus Rapid Transit (BRT)
 - spatiotemporal issues in deploying bus-only lanes

China's economic growth:

e.g.

- average growth rate of 9.6% for nearly 30years
- per capita GDP: approx US \$2000
(nearly US \$8000 with purchase power parity)

China's growth in urban population



Projection: 70% of Chinese will live in urban settings by 2035

China's rapid Motorization

In Chinese cities auto ownership approaching 100/1000 people!

Urban Congestion!

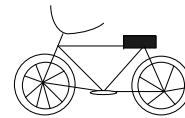


China's government response: focus on transit

- Urban space taken by roads \approx 10% in China
(20~25% in European cities)

Compared to automobiles, a roadway lane can carry ...

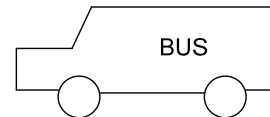
4-5 times more bicyclists



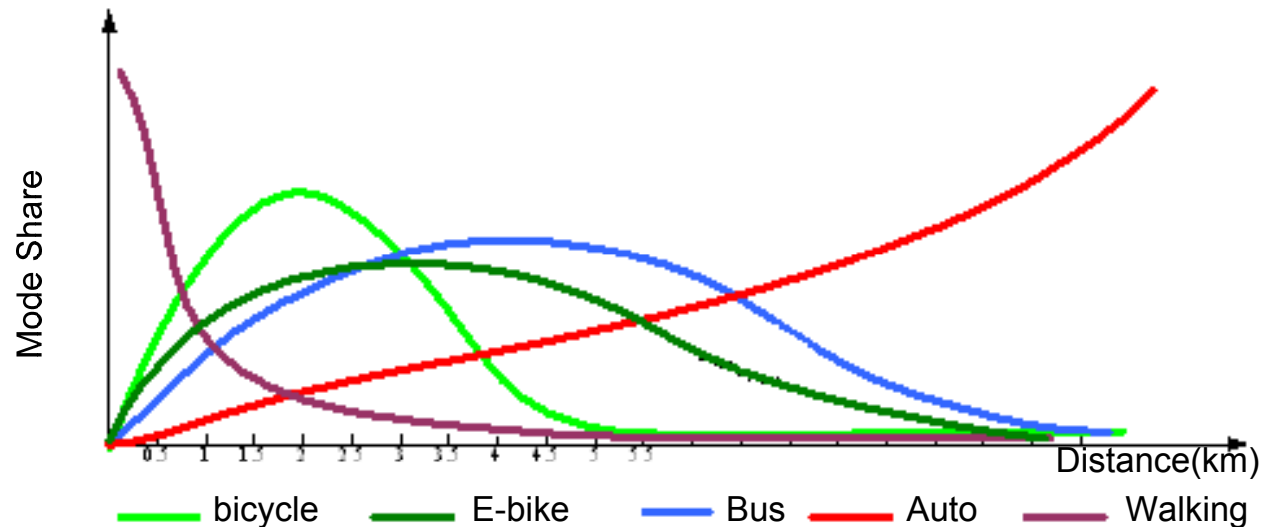
8-10 times more pedestrians



15-20 times more transit riders



China's government response: focus on transit



Central governments' benchmarks for Chinese cities of certain size:

- **30% transit Mode share**
- **50 min (max) for all transit trips**
- **etc**

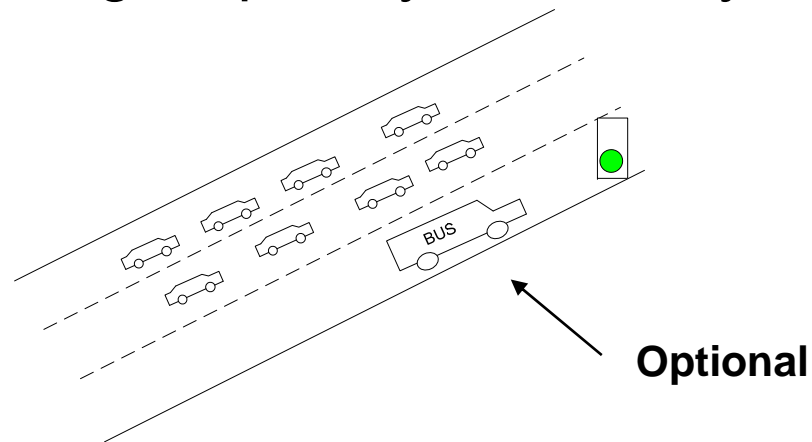
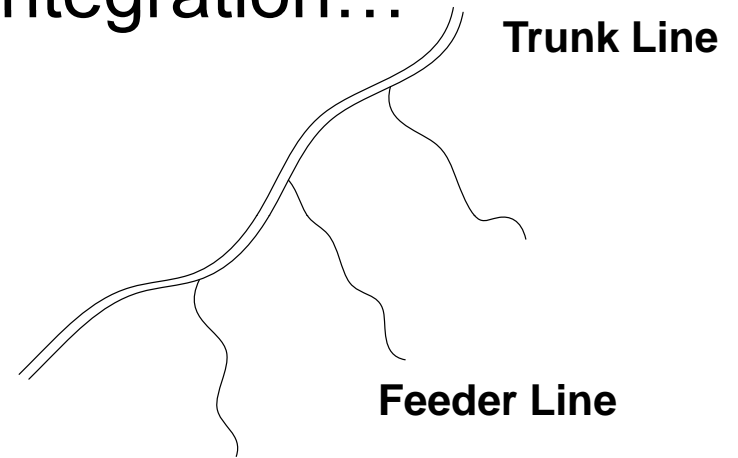
Berkeley researchers And Chengdu partners

Improve transit accessibility & integration...

via feeder bus systems

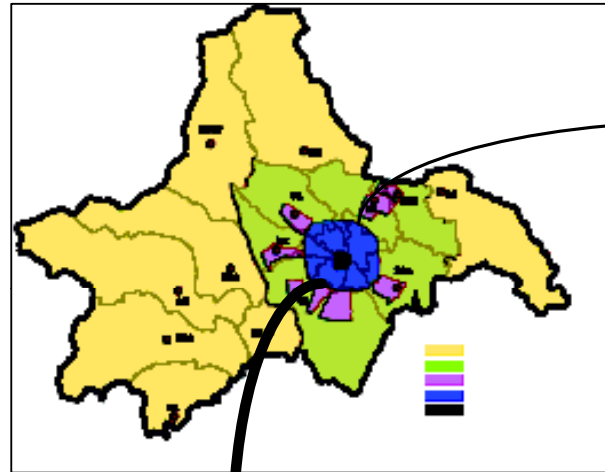
Improve transit performance...

via transit-signal priority & bus-only lanes

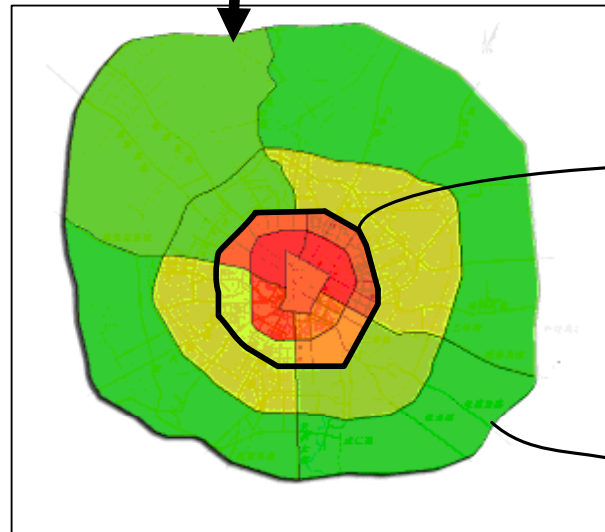


Chengdu

Metro Chengdu

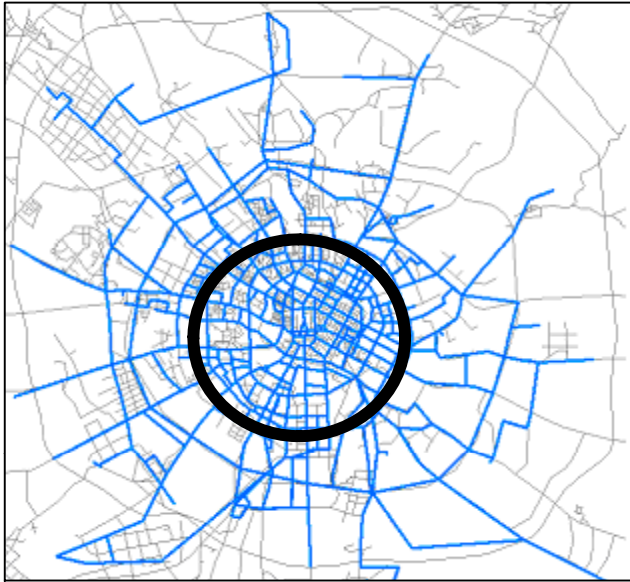


Urban Core



2nd ring
(radius=3.2km)

Outer ring



**Chengdu's existing
Bus routes**



**Chengdu's planned BRT
(red & blue lines, green circles)**

Feeder bus system

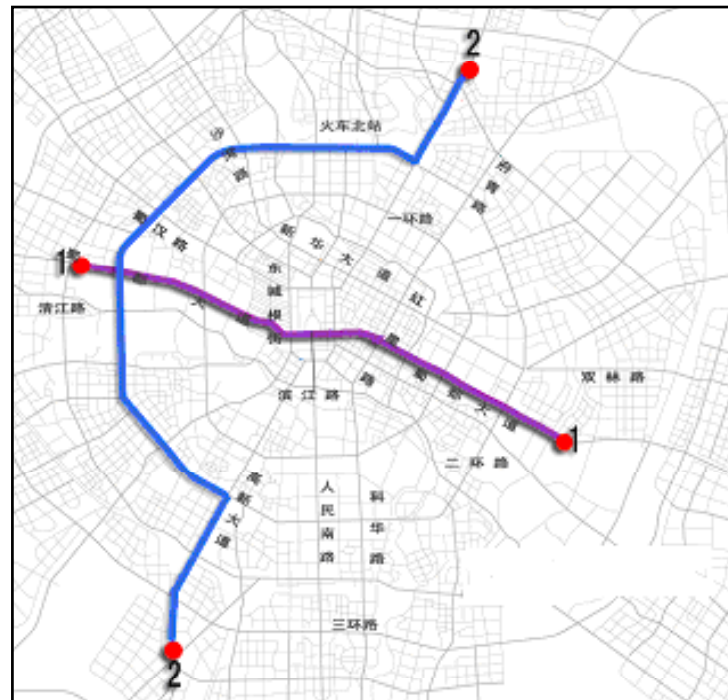
We pose the question:

What are the “resource requirements” for a feeder system...

- **to meet specified benchmarks**
- **given cost parameters (users & operators) and system parameters**

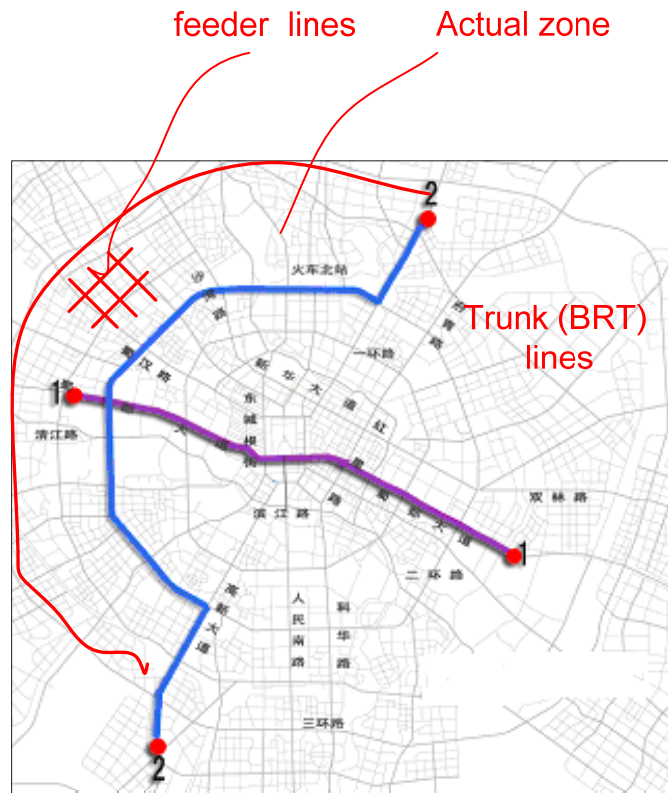
In the shorter term

Chengdu's initial (test) BRT network:

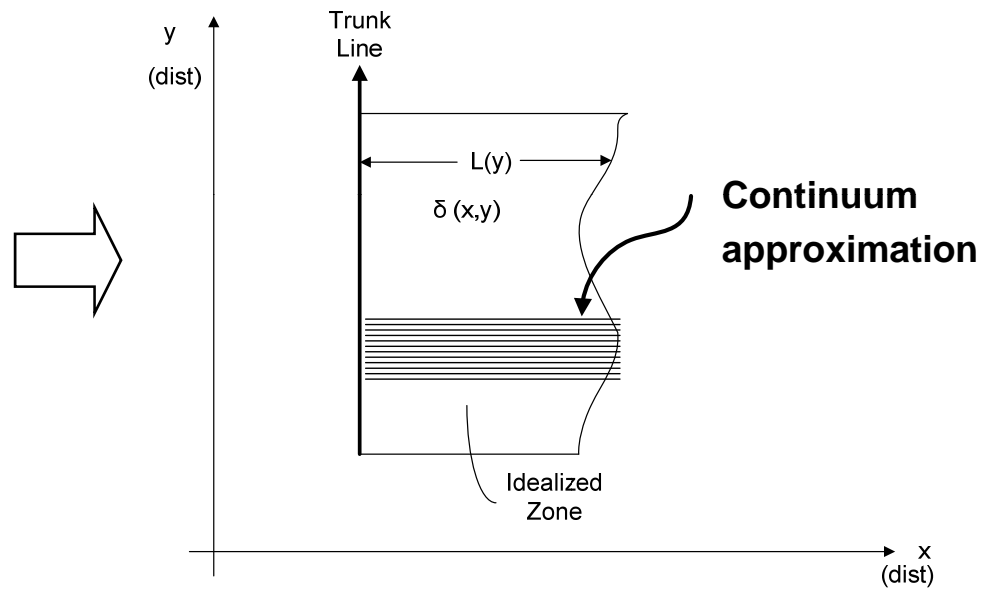


**Governments' performance benchmark:
All transit trips within some maximum**

Actual Environment:



Idealization:

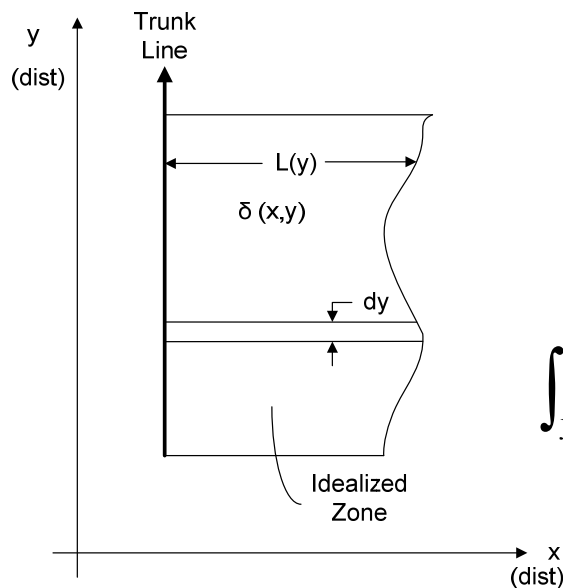


- (i) stop density along feeder route, S
- (ii) feeder line density, $d(y)$
- (iii) optimal feeder bus frequency, $f(y)$

Resource Requirements

Recall: $d(y)$ = feeder line density at y

$f(y)$ = feeder bus frequency at y

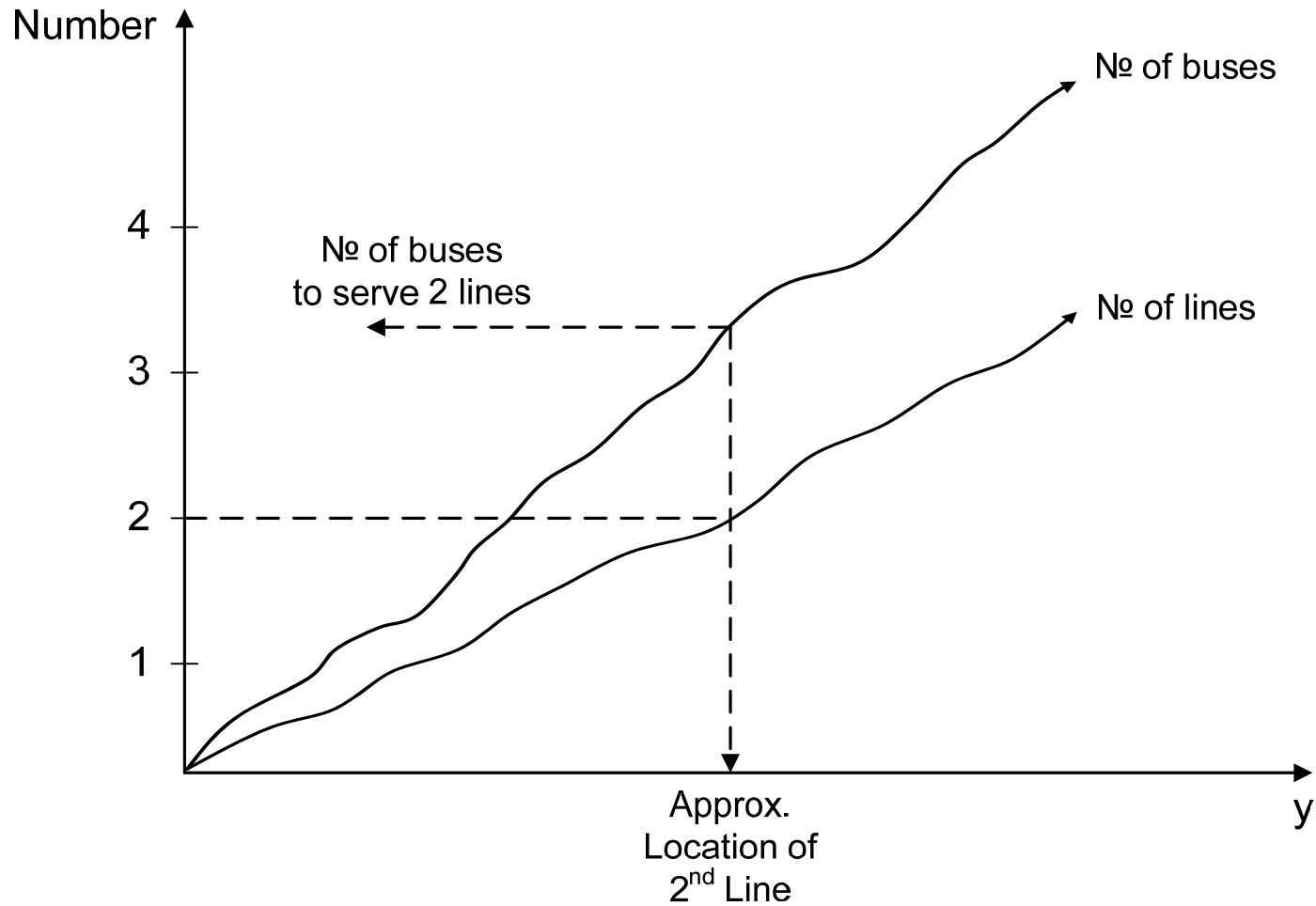


$$\int_y d(y) dy \implies \text{Cumulative number of lines to } y$$

$$\int_y \frac{d(y) \cdot L(y)}{V \cdot f(y)} dy \implies \text{Cumulative number of buses used to } y$$

Where, V = average speed of a feeder bus

Resource Requirements

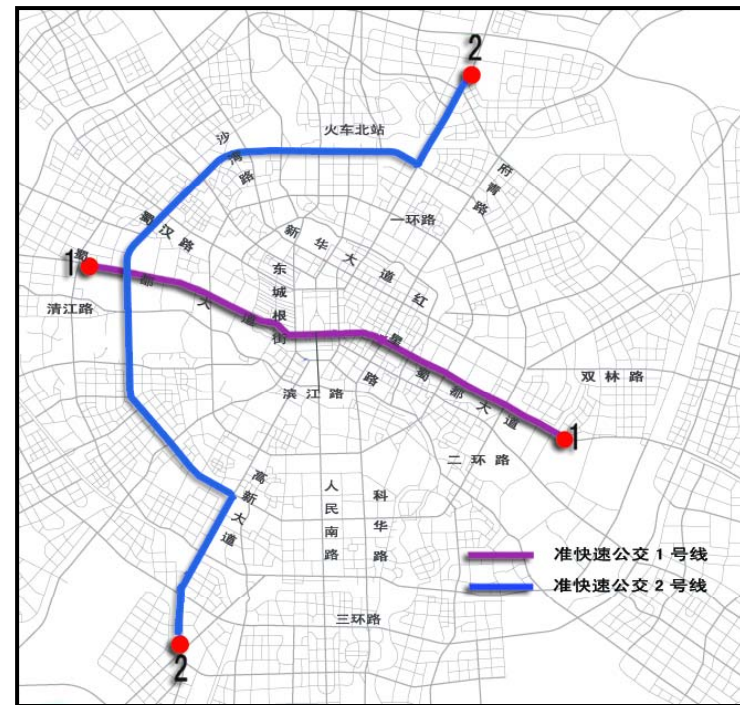
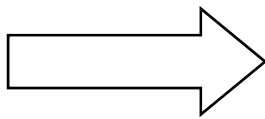
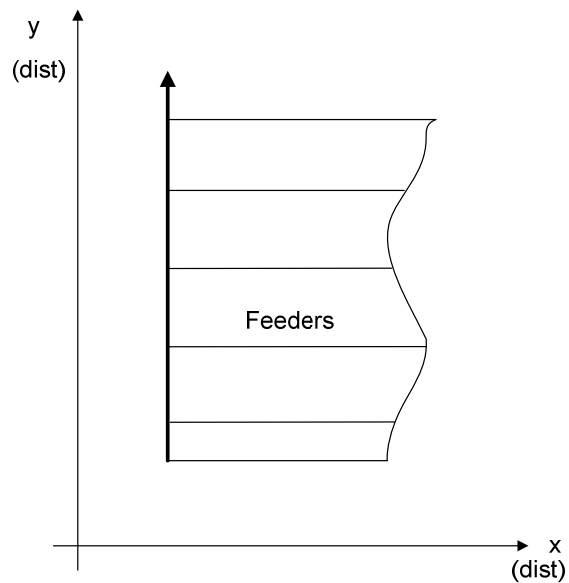


The Advantage:

Before considering details of network & ridership demands, we can estimate the resources required to reach a certain accessibility goal, and we can layout a preliminary feeder system

Fine Tune:

Idealized system



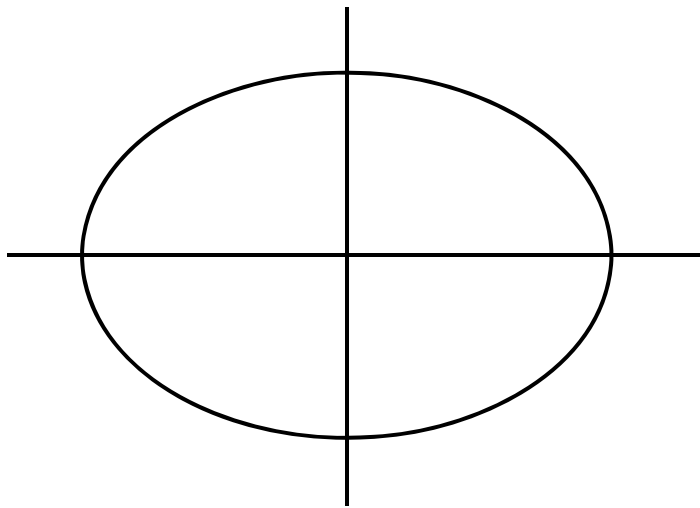
In the longer term

Given a certain trunk network, identify areas with inadequate mobility and furnish feeder service there

In Chengdu: based on long-term proposed trunk network

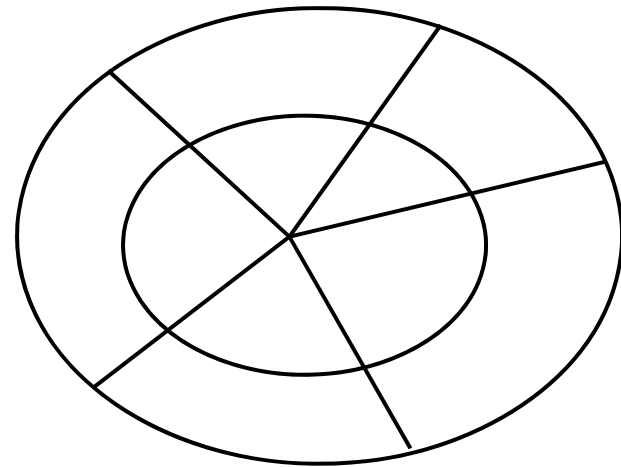
More generally:

Alternative 1



VS

Alternative 2



A Related Effort

- Bus Rapid Transit, BRT
(including on ring roads)

Spatiotemporal Issues

Regarding space:

a fixed number of lanes can go everywhere

(or can change in some places)

Regarding time:

number of bus lanes can change by time of day

Avoid wasted space

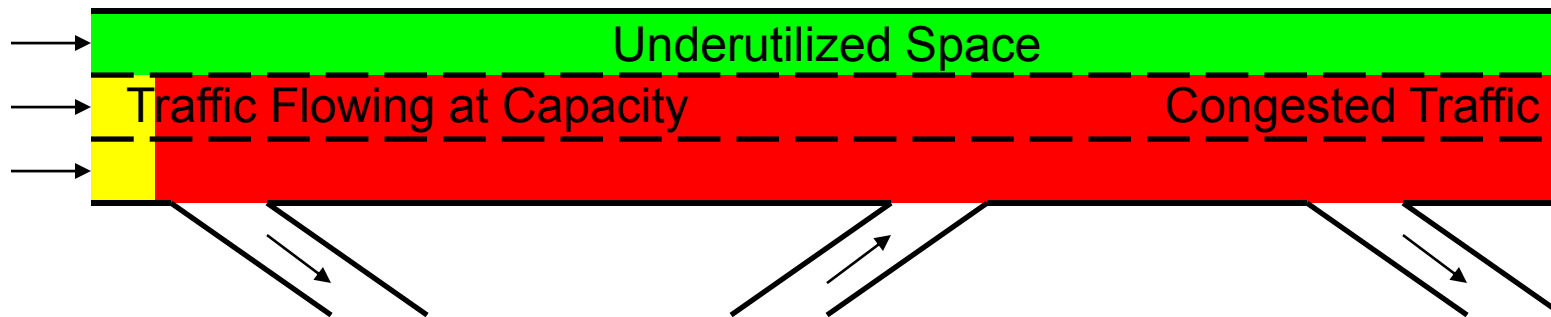


Findings: 2 Modes

~~When partially congested and underutilized...~~

with all lanes for mixed modes

Car queues in the adjoining space can expand

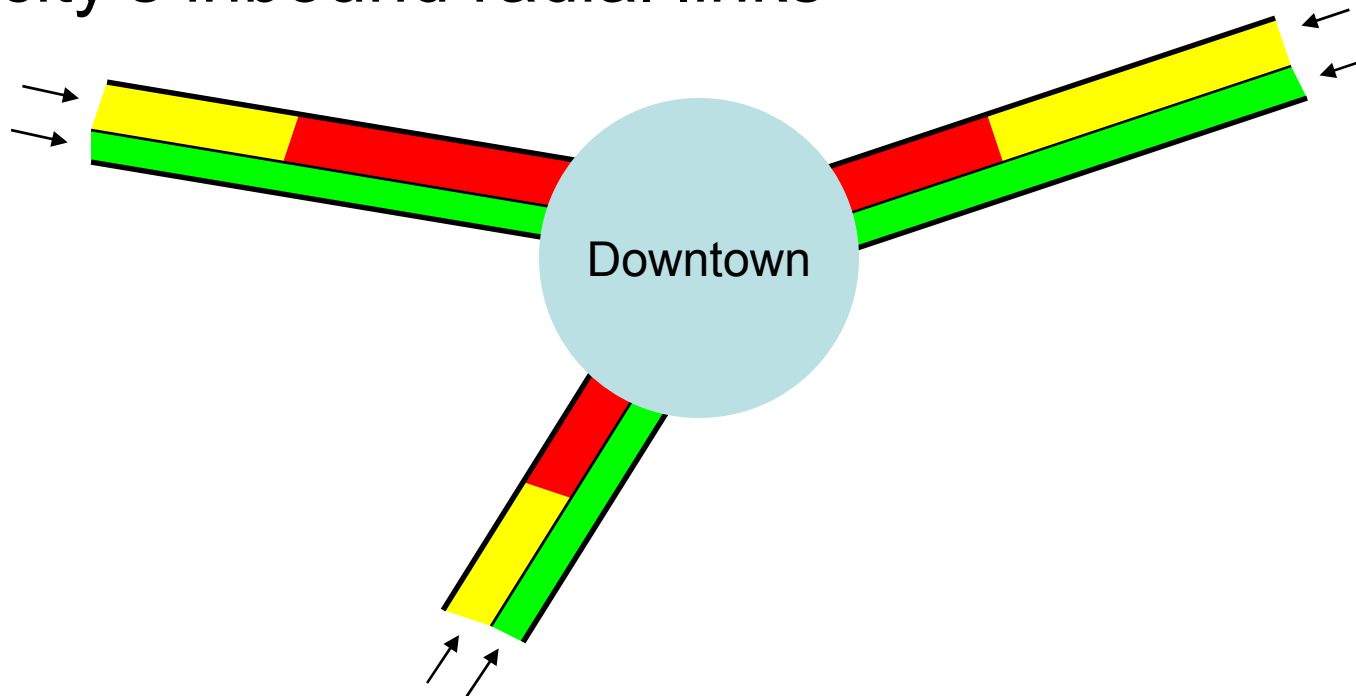


With underutilized bus lane

Findings: 2 Modes

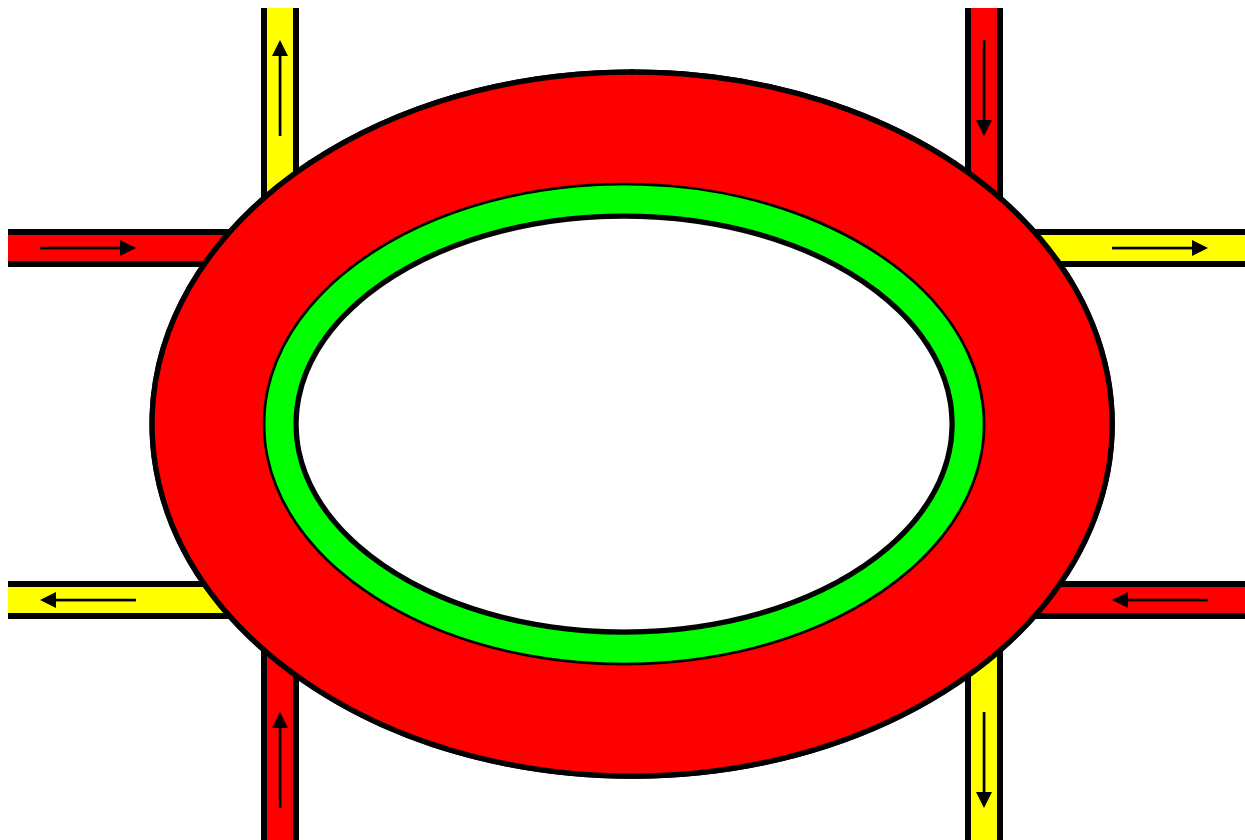
- If queues have room to expand, total system output (and vehicle delay) does not change much
- Accessibility increases by giving priority to buses

e.g. a city's inbound radial links

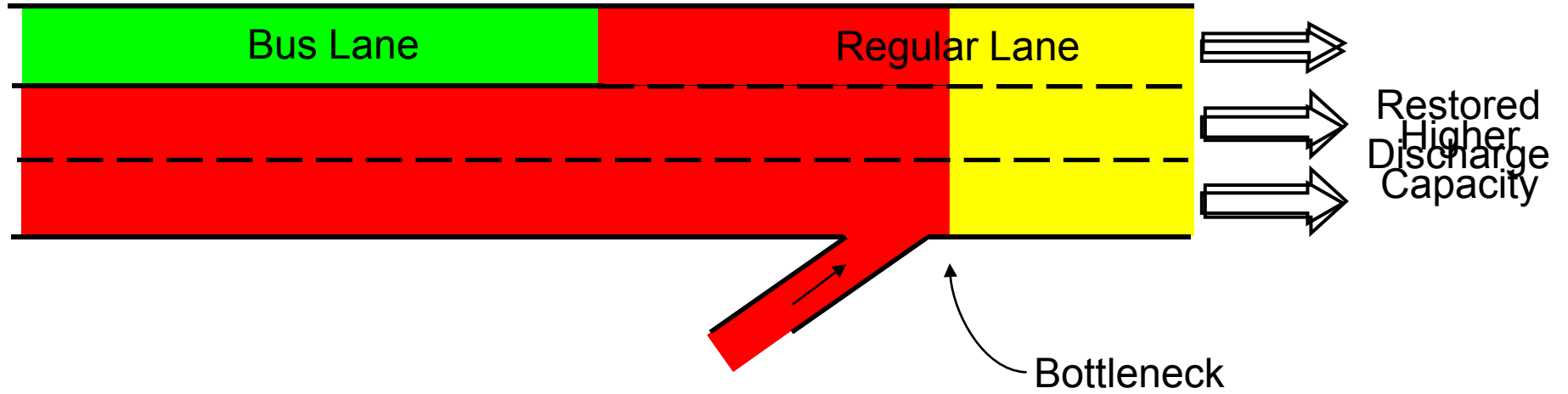


A Bad Candidate:

Congested downtown beltway



Smoothing Effect



Many opportunities exist

Much work to be done