TRANSIT PRIORITY and BRT

Outline:

- Introduction
- Bus Stops
- Bus Lanes
- Signal Priority
- Bus Rapid Transit

It’s Time for Bus Priority

- Bus service will always be essential
  - Rail’s reach is limited / its cost, prohibitive
- Rail gets “ultimate” priority
  - Should bus have no priority at all
- Priority is a strong way to counter bus’s negative image
  - Priority indicates that society values bus
  - Priority makes bus service more competitive

Bus Service Quality Is Too Often an Accident

Without Protection:
- Slow
- Unreliable
- Bunched
- Crowded

With Protection:
- Fast
- On time
- Regularly spaced
- Even loads

"Bus Rapid Transit"

Bus Stops Location and Policies

- <u>Far-side</u> (vs. Near-side)
  - less queue interference
  - easier pull-in
  - fewer ped conflicts
  - snowbank problem demands priority in maintenance
- <u>Curb extensions</u> benefit transit, peds, and traffic (0.9 min/mi speed increase)
- <u>Pull-out priority</u> (it's the law in some states)
- <u>Reducing dwell time</u> (vehicle design, fare collection, fare policy)

Bus Priority Measures in Space
Bus Lane

The “traditional” priority measure

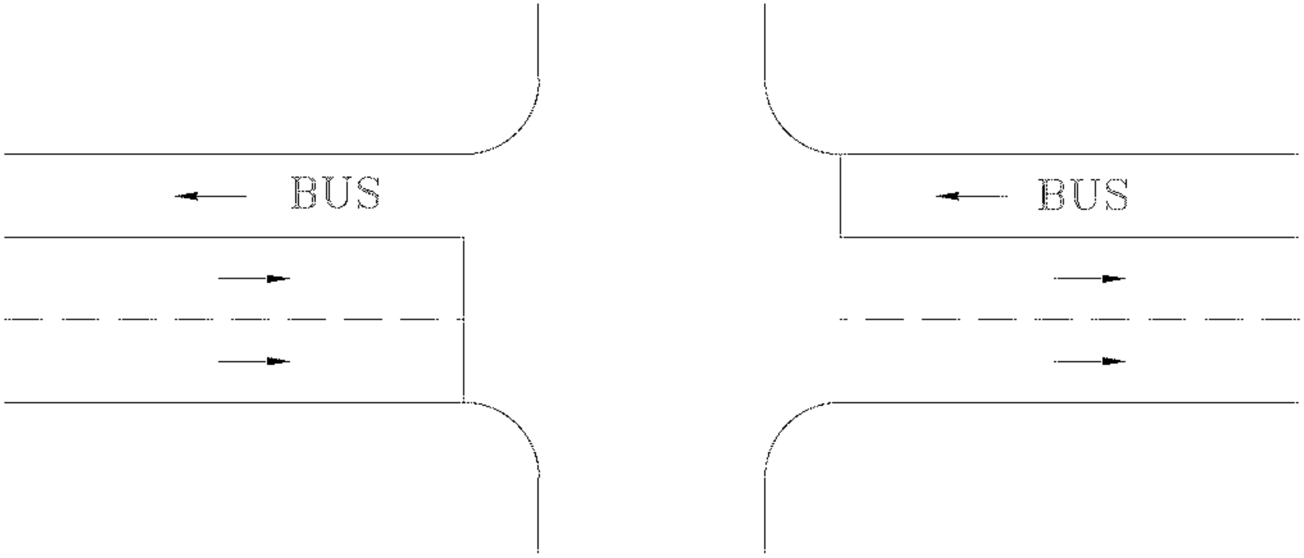
- Enforcement, especially vs. parking
- Turn restrictions

Political dilemma requires foresight

- If there’s little traffic: “Buses don’t need it”
- Traffic grows: “Buses can’t have it.”

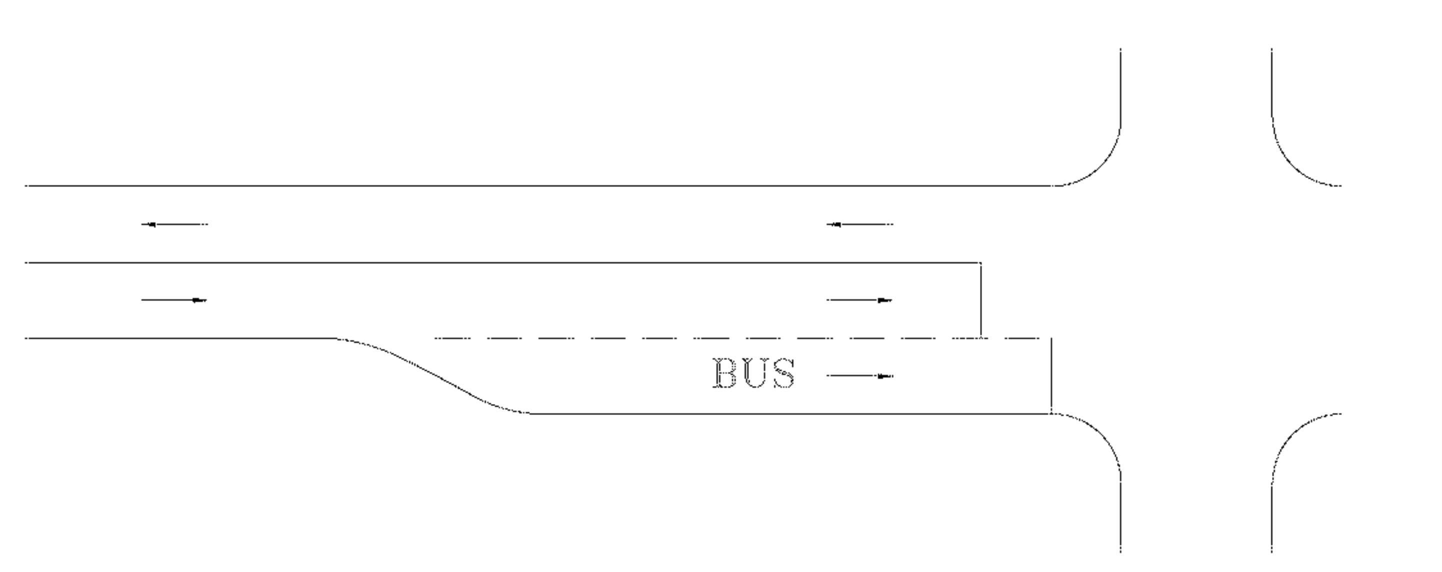
Bus Priority in Space
Contraflow Bus Lane

Av. Ponce de Leon, Santurce, PR



Queue Jumper Lane

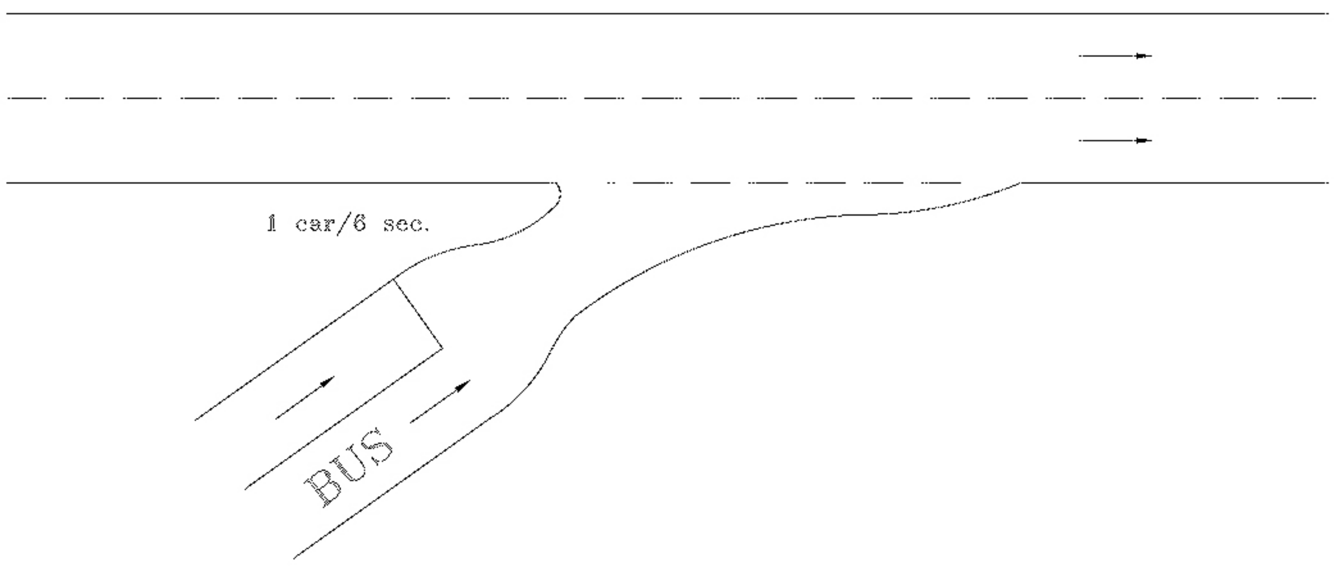
Common in the U.K.



Queue Jumper with Ramp Metering

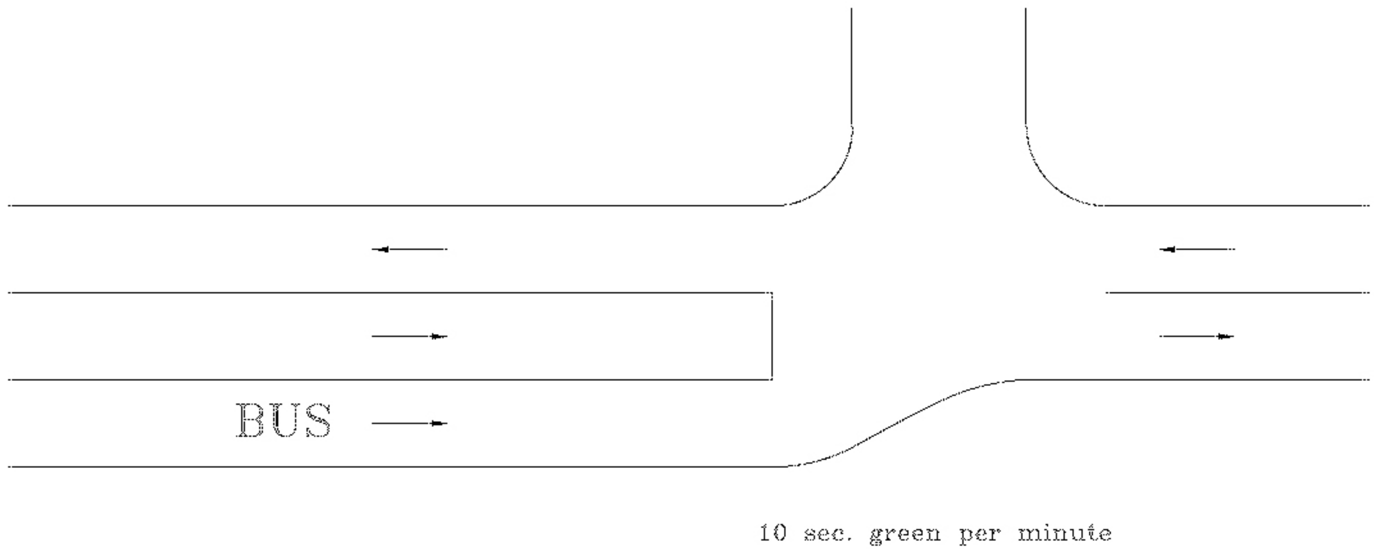
Metering Needed Due to Oversaturation

Metered on-ramp, Seattle area freeway



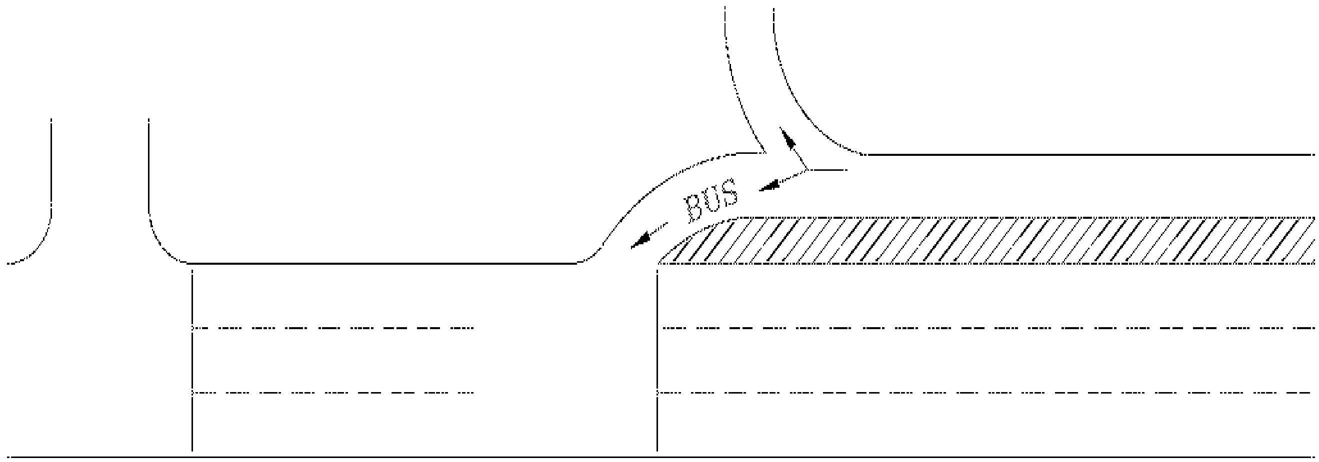
Queue Jumper with Bottleneck Metering

Arterial entering inner part of Eindhoven, the Netherlands



Bypass on Saturated Arterial

- Frontage road provides local access, bus bypass
- Bus-activated gate for entry control
- Signal at bus entry meters traffic so entering bus won't join a long queue



Priority in Time = Signal Priority
Passive Priority

Signal timing that helps transit without actively detecting a transit vehicle

•Short cycles (help peds, too!)

San Diego Trolley example (downtown, at grade)

- **Signals are pretimed for trolley progression**
- **Through band for trolleys every 2 minutes**
- **Suitable for high frequency service with predictable running & dwell times**

Active Priority at Signals
1. Detection

- **Prefer *local* detection: transponder, smart loops, dedicated short-range radio**
- **Location: *predict* vs. *respond***
  - **Near side dilemma (or not)**
- **Exit detector (stopline) to avoid waste**
- **Detectors on all approaches for queue management**

Active Priority at Signals
2. Control Tactics

- **Extend green (++)**
- **Early green**
- **Early red (to hurry the next green)**
- **Skip, insert, or resequence phases**
- **"Near-side flush:" (a) green to clear bus stop; (b) short red during dwell; (c) green**
- **Advanced prediction: adjust phase lengths so that transit arrives on green**
- **Recovery tactics: restore capacity, dissipate queues**

“Interruptible” Traffic Signal Control

- For auto traffic, focus on *capacity*, not *progression*
  - lose progression: travel time increases a little
  - lose capacity: travel time increases a lot, jams the road
  - Overlaying priority on arterial progression is too limiting
- Resolve competition between priority calls
- Bus saves 12-15 s per intersection
- No significant capacity loss
- Auto travel time increases a little (justice?)

Conditional Priority as a Means of Operational Control

Eindhoven, the Netherlands

- **On-board computer monitors location, schedule deviation**
- **Priority granted if bus is 20 s late**
- **Provides push / pull needed to keep bus on schedule**
- **Less traffic interruption**
- **Requires finely tuned schedule, which requires extensive data collection & analysis**

Evaluations Based on Mean Values Understate Benefits

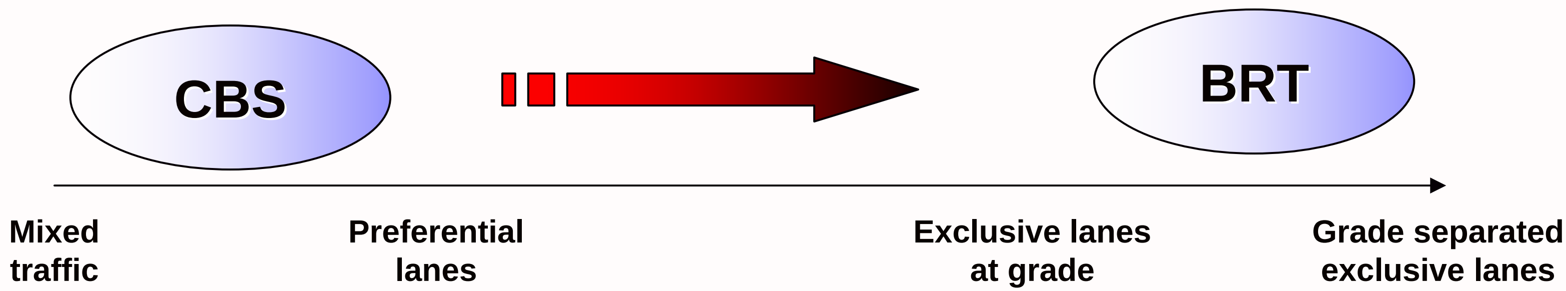
- Running time impact (Boston study)
  - mean: reduced 10% (30 min to 27 min)
  - 95-percentile value: reduced 23% (38 to 29 min)
- Crowding impact
  - mean: no change (since headway is fixed)
  - 90-percentile value: reduced 12% (166 to 145)
- Operating cost is usually tied to 90- or 95-percentile: savings is 33%, not 10%
- Passenger satisfaction: also tied more to 90- or 95-percentile values

A Policy of Congestion Protection

- Cycle: slow buses ⇔ more cars
- Minimizing person-delay for fixed demand fails to account for demand effect
  - Transit benefits: amplified by new customers
  - Auto losses: diminished by rerouting
- Consistency with other efforts to influence mode choice
- Overcome interagency leadership vacuum

The BRT Challenge

As we move from current conventional bus service (CBS) towards a higher quality system Bus Rapid Transit (BRT).”



- **What are the critical choices in system design?**
- **How do we model the system?**
- **How do we evaluate it?**

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Key BRT Attributes

Physical

- Right-of-way priority
- Expedited boarding and alighting
- Stops
- Vehicles
- Fare Collection

System

- AVL system
- Signal system
- Passenger information system

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Key BRT Attributes

Service

- Knowledge-based planning and operations
- High frequency
- High reliability

Control

- System
- Distinct image
- Connectivity
- Land use integration

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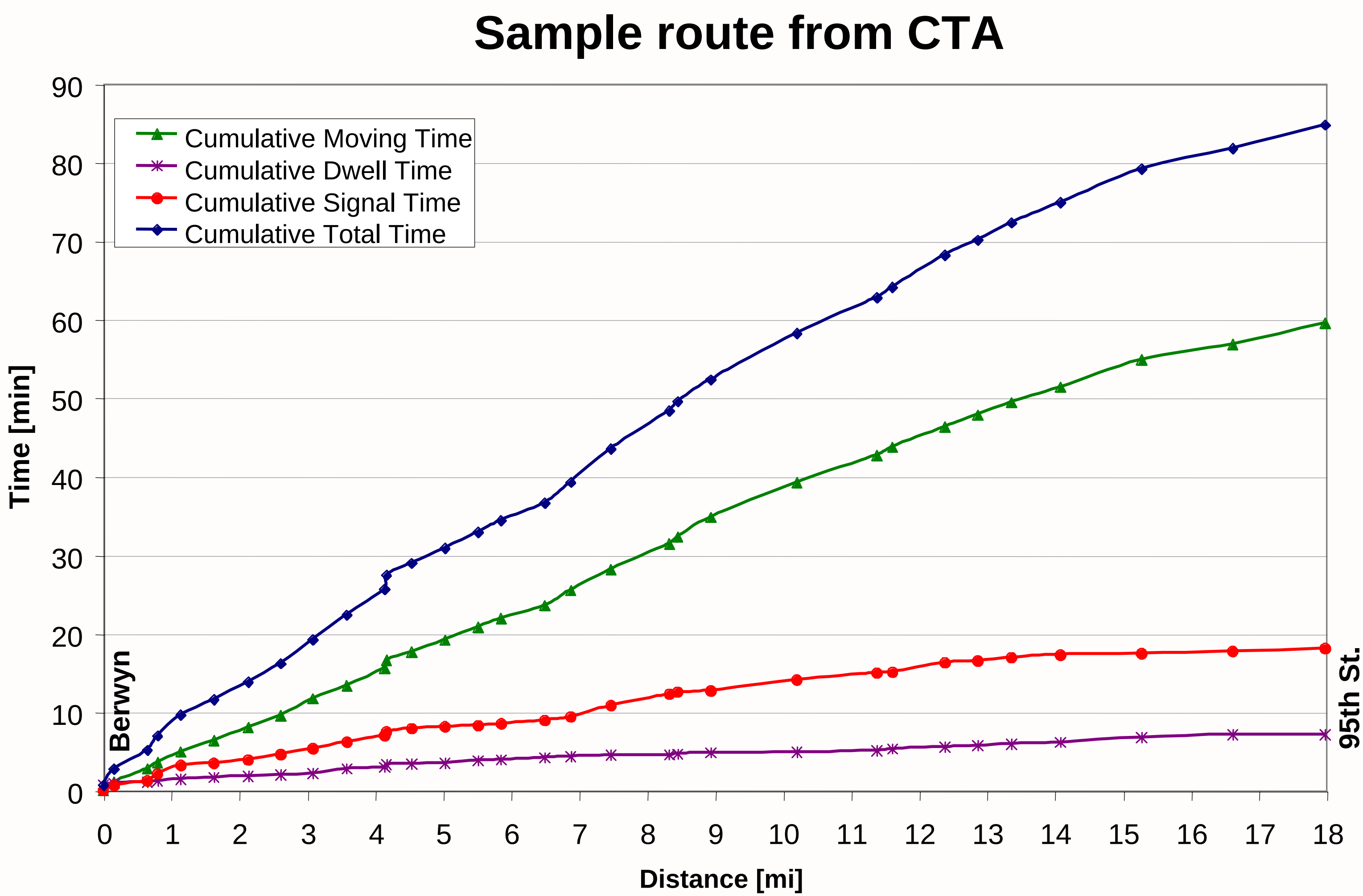
CBS Typical Travel Time Components



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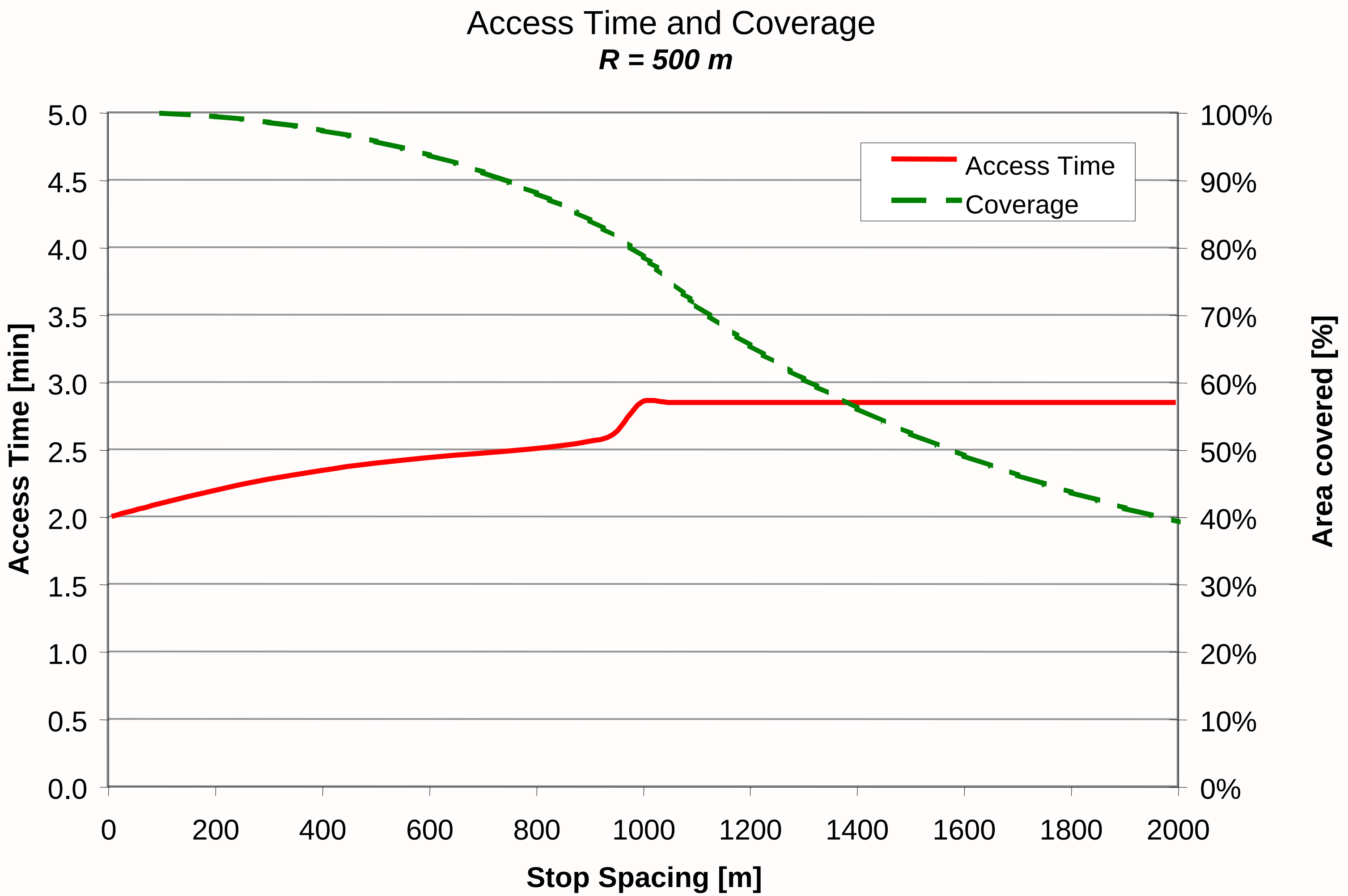
Trade-off: Stop Spacing vs. Access Time



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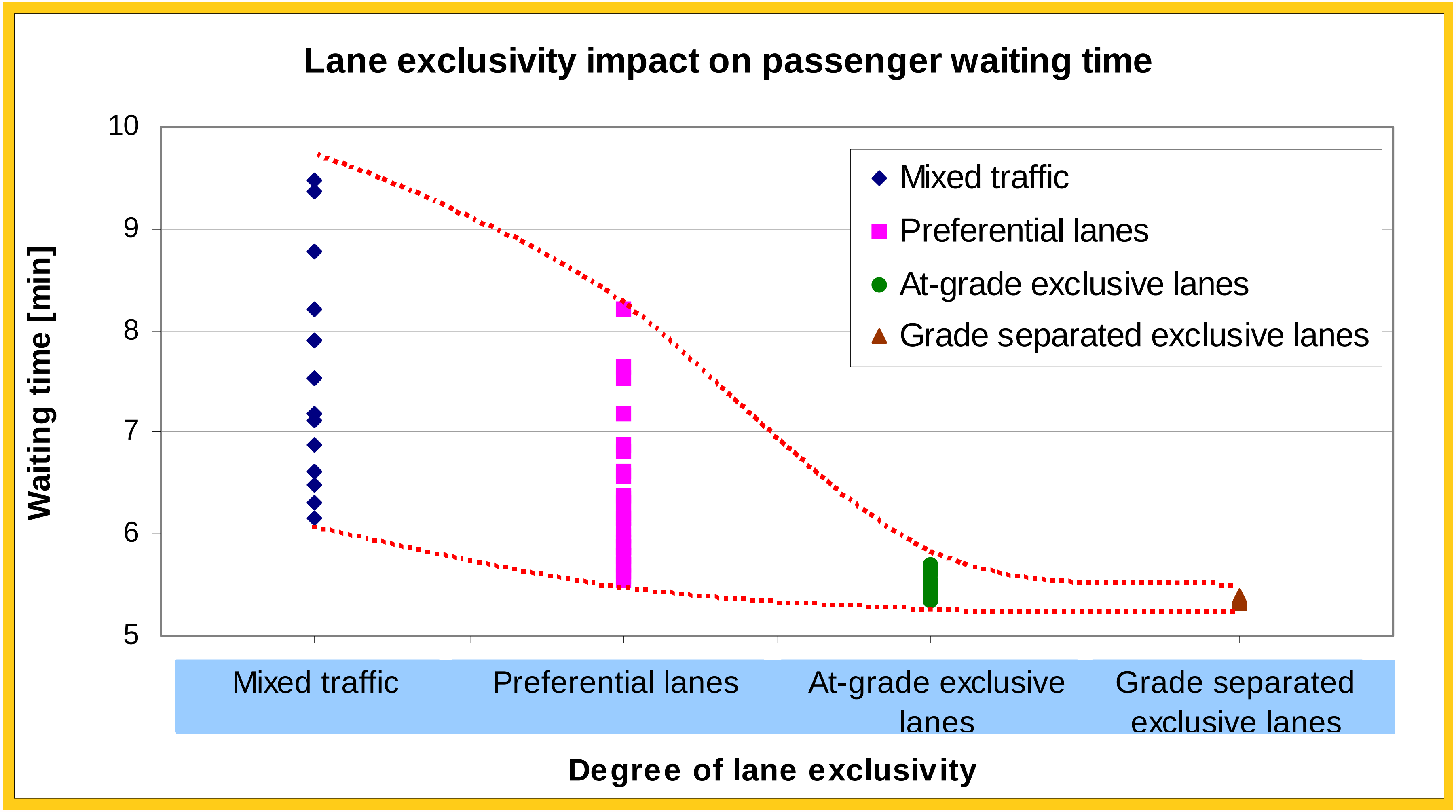
Trade-off: Lane Exclusivity vs. Waiting Time



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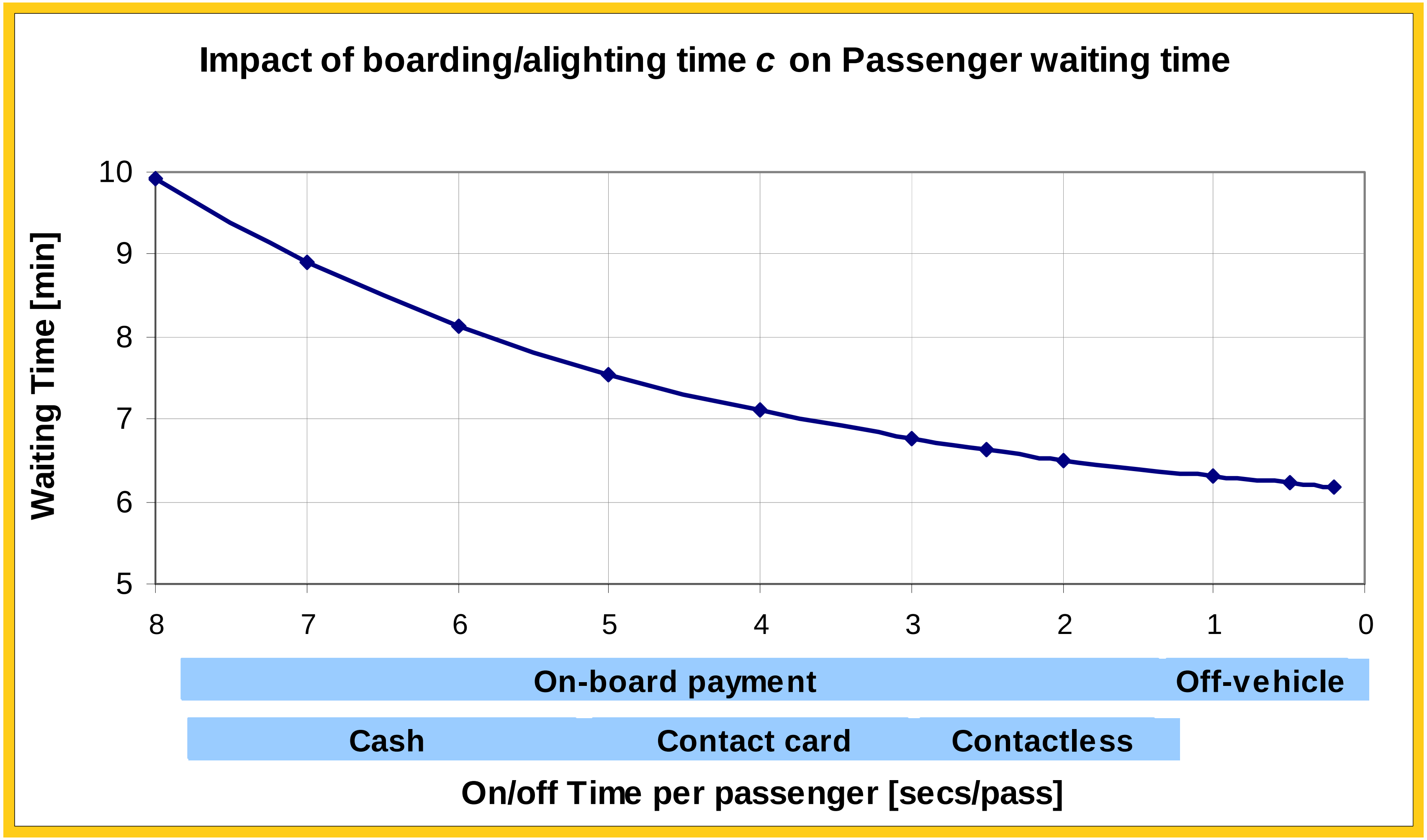
Trade-off: Boarding/Alighting Time vs. Waiting Time



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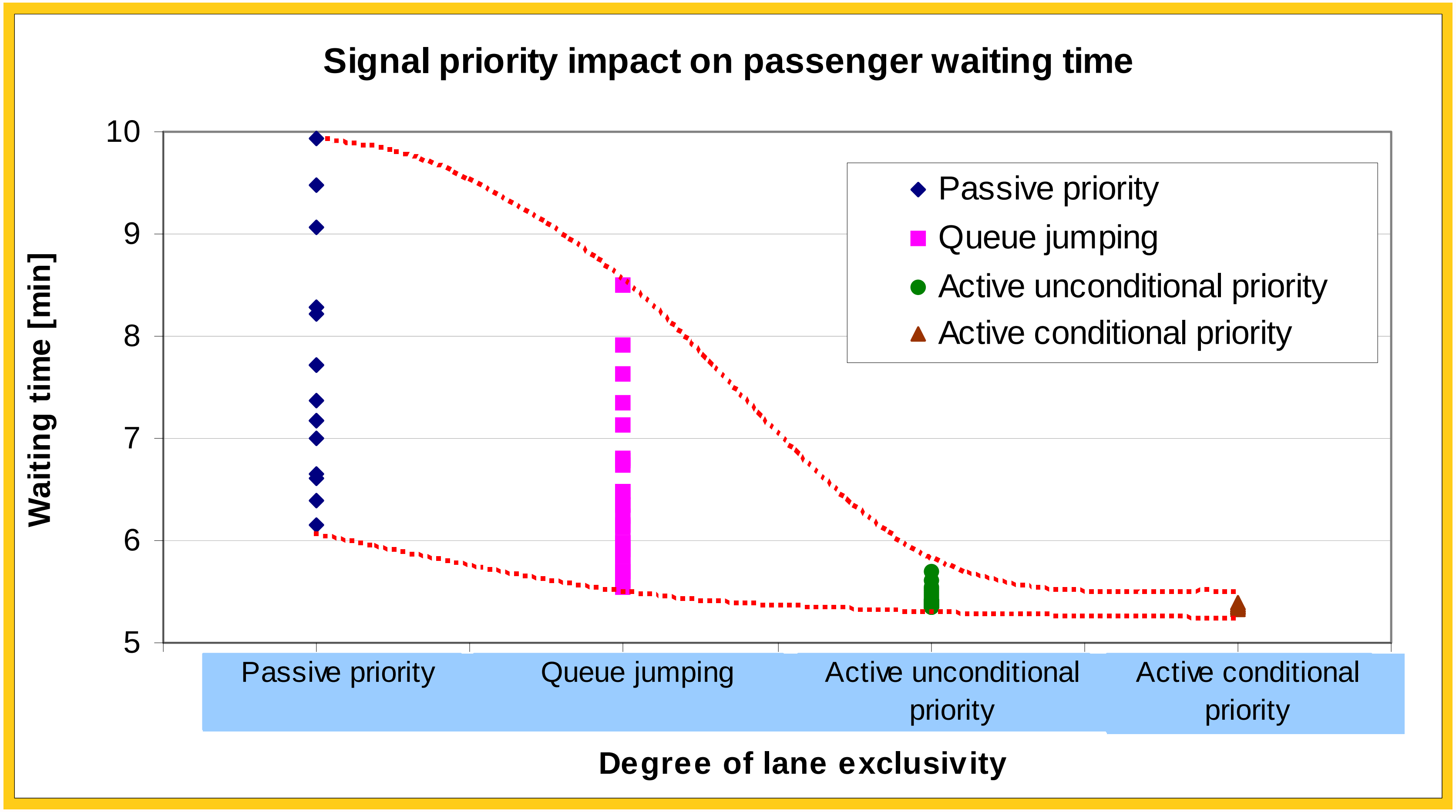
Trade-off: Signal Priority vs. Waiting Time



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Modeling

- Two different scales:
  - Corridor level:
    - Description of the transit experience
    - A building block for BRT
    - Focus on access and operational issues
  - System-wide level
    - The impacts on modal choice and ridership
    - Changing perceptions of choice riders
    - Appropriate network configurations incl. transfers
    - Competing with parallel improvements for the automobile driver

Evaluation Measures

- Primary objective is ridership
- Ridership gains come from LOS improvements
- Two challenges:
    - Forecasting of LOS gains
    - Forecasting of ridership as a result from LOS gains

Typical Evaluation Measures
(Obviously conditioned by our own analytical approach!)

Group	Category	Evaluation measure
Users	Travel Time	Access Time
		Waiting Time
		In-vehicle Time
Agency	Operation Costs	Running time
	Capital costs	Infrastructure cost
		Technology cost

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Impact Matrix Evaluation

			CRITICAL VARIABLES								
			Lane exclusivity	Guidance	Spacing	Boarding level	Bus capacity	No. doors	Transaction location	Fare media	Priority method
IMPACTS	Users	Access time			X						
		Waiting time	X			X	X	X	X	X	X
		In-vehicle time	X	X	X	X		X	X	X	X
		Running time	X	X	X	X		X	X	X	X
	Agency	Infrastructure cost (road & vehicles)	X	X	X	X	X	X	X		
		Technology Cost		X					X	X	X

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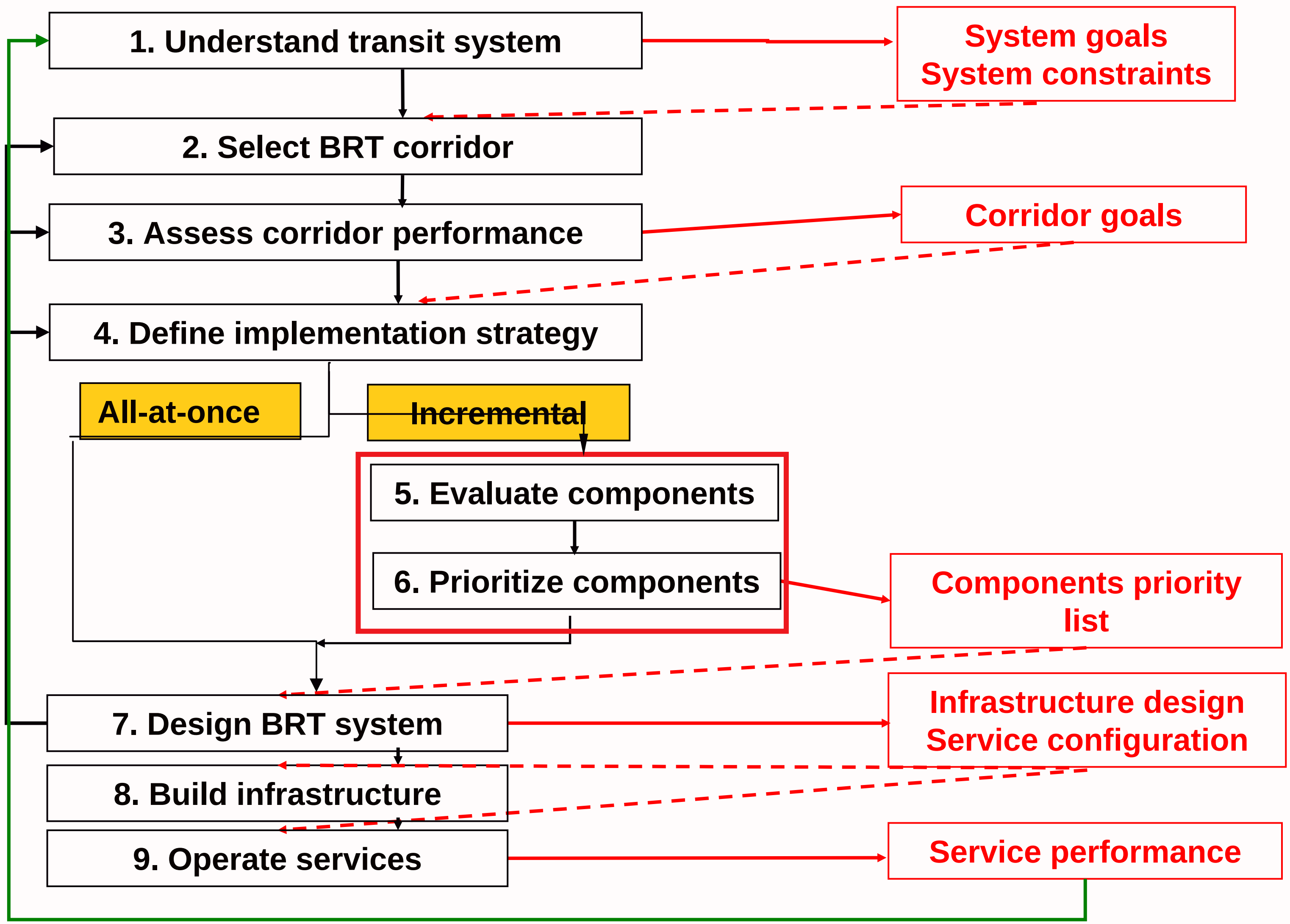
Usual Evaluation Elements

- Ridership gains
- Benefits =time savings as % of current time
- Infrastructure, technology, and operational cost
- Average cost to achieve one percent time reduction for each alternative

- Choice of a prioritization criteria:
  - Users: travel time cost-effectiveness
  - Agency: running time cost effectiveness
  - Both: travel + running time cost effectiveness

BRT Implementation Process



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