

TFLEx Guide for Transit Newbies

Module 2A: Bus and Rail Planning and Scheduling

BUS AND RAIL PLANNING AND SCHEDULING

Introduction

The Transit Finance Learning Exchange (TFLEx) – created and run by your transit finance colleagues – exists as a strategic alliance of transit agencies. TFLEx has developed a body of reference material (“TFLEx Guide for Transit Newbies”) to educate finance staff in the field of transit without extensive costs. This coursework can be accessed at www.TFLEx.org.

Welcome to Module 2A: Bus and Rail Planning and Scheduling

This module will give you an overview of transit planning and scheduling, including Service Planning, Scheduling, Blocking and Runcutting.

After completing this module, you will be able to:

- Discuss critical success factors in public transit
- Identify the criteria that go into the development of bus routes
- Explain the basic concepts and route types used in scheduling
- Define how routes are blocked to create vehicle assignments
- Describe the considerations involved in creating runs for operators through runcutting

Additional Information

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CPE Credits

TFLEx members will earn 1.0 CPE credit upon successfully completing a knowledge test (qualified assessment) for this module. Upon gaining an understanding of the material in this work and completing the review questions, contact Joe Costello, TFLEx Executive Director, at CostelloConsultingCorporation@gmail.com. He will provide you with a final knowledge test. You will have 30 days to send your answers to Mr. Costello. Upon answering at least 70% of these questions correctly, you will receive a certificate of completion for the 1.0 CPE credit, as well as evaluative feedback.

Not a member of TFLEx? Please reach out to Joe Costello, TFLEx Executive Director, at CostelloConsultingCorporation@gmail.com to find out how your agency can join. We encourage you to do so. We know you would get great value in being part of this organization!

About TFLEx

The Transit Finance Learning Exchange was founded in 1999 by a number of transit agencies and continues to be run by your transit agency colleagues.

TFLEx offers semi-annual workshops, Forum and Special Interest Group Calls, training and professional development, comparative metrics, and, of course, invaluable networking. Of note, TFLEx members meet twice annually to explore topics of mutual interest, share relevant experiences, and develop best practices. These are facilitated workshops where all attendees participate in the discussions. As TFLEx is run by your transit finance colleagues, the workshops offer an opportunity for further follow up at the next workshop and Forum and SIG (special interest group) calls – Zoom calls on topics of interest held between workshops. The workshops and calls provide continuing education credits.

Visit www.tflex.org for more information and dates of upcoming calls and workshops.

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OVERVIEW

In this first section, we will discuss the critical success factors in public transit.

What are the critical success factors for continued or improved ridership levels? What impact do planning and scheduling decisions have on transit operations?

Key Concept 1: Critical Transit Success Factors

Improving, or at least maintaining, ridership levels is an underlying goal of every transit agency. To do this, the agency must implement an effective network of transit modes and routes. Designing an efficient, effective transit network hinges on certain critical success factors in the areas of: Planning & Scheduling and Operations & Maintenance. This module focuses on Planning and Scheduling. Operations and Maintenance are covered in a separate module.

▪ **Planning & Scheduling**

- Access – How far is the nearest bus stop, transit center or rail station? Does transit provide access to the destinations I need? Does it go where I need it to go (home, jobs, shopping, entertainment, etc.)?
- Frequency and headways – How frequently does the service run? If I miss my bus or train, how long do I have to wait for the next one?
- Convenience – When I take a trip, how convenient is it? How direct is my trip? Does it get me from my origin to my destination quickly? What is the time differential between transit and other alternatives (driving my car, rideshare trip, etc.) Will I have to transfer between vehicles? If so, how many times?

▪ **Operations**

- Service Reliability – How close to the published schedule does the bus/train arrive to pick me up or drop me off? Can I count on this service to be delivered consistently day after day, week after week?
- Safety – Does the driver operate the vehicle in a safe manner? If no seats are available on the vehicle, do I have something I can conveniently hold to steady myself?

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- Security – Do I feel secure on-board transit vehicles and at facilities? Is there adequate lighting at night at stops, stations, parking lots/garages? Have I observed any suspicious characters or criminal activity?

Maintenance

- Comfort – Are the seats on the vehicles and at facilities comfortable to sit in for the length time I will need to be there? Is there sufficient availability of protection from weather at rail stations and transit centers? Is the temperature on board vehicles or in facilities comfortable? Is it cool enough in the Summer and warm enough in the Winter?
- Cleanliness – Are the vehicles and facilities clean, both inside and out? If there are bathrooms, does it appear that they are well-stocked with soap and paper goods? Does it look like they have been cleaned recently? Are trash receptacles available and not overflowing? Do the vehicles and facilities smell clean, or at least not smell bad? Do the vehicles or facilities have visible graffiti?
- Vehicle reliability – Does the vehicle run properly? Are there frequent break downs? Does the vehicle appear to be in good working order (no broken lights, no squealing breaks, no unusual noises, no excessive exhaust, etc.)?

Learning objective: You're off to a great start! Let's test what you've learned about the critical success factors in public transit.

Review Questions

1. Which of the following is NOT a critical success factor for transit?
 - a. Vehicle reliability
 - b. Good accounting
 - c. Frequency of service
 - d. Safety
2. Runcutting involves which of the following activities:
 - a. Determining the modes of service to be offered.
 - b. Assigning vehicles to routes
 - c. Determining exact time schedules for bus routes
 - d. Matching operators to routes and blocks of service.

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Answers

1. The correct answer is B. While obviously good accounting is critical to the success of any organization, it is not one of the 9 factors listed above as critical to transit success. An organization can have a good accounting department and not have transit success. Good planning, operations and maintenance will have much more impact on the success of a transit agency than good accounting.
2. The correct answer is D. Runcutting creates operator assignments.

Key Concept 2: Service Planning & Scheduling Activities

Decisions in the areas of Planning, Scheduling, Operations and Maintenance all affect critical transit success factors. In this module, we will focus on the four processes of bus and rail service planning shown below:

- Service Planning is the process of designing and optimizing a system of routes and services to meet a community's mobility needs.
- Scheduling determines, based on several variables, where, when and how often vehicles run.
- Blocking organizes the service into efficient "blocks" of service.
- Runcutting is the process of assigning driver/operators to runs carved out of the blocks of service.

Each of these concepts will be discussed in more detail below.

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SERVICE PLANNING

In this section, we will examine the criteria that go into the development of bus routes.

Service Planning is the foundation of all public transit operations. Before a single bus departs or a train leaves the station, planners must determine where service is needed, how often it should operate, and how it will integrate with other transportation modes. Effective planning aligns a community's mobility needs with the agency's operational and financial capacity, ensuring that public investment delivers maximum benefit to riders and taxpayers alike.

Transit planning combines data analysis, policy objectives, and community engagement into a cohesive, complementary array of transportation services. It is both a technical and social process. Planners use quantitative tools to forecast demand but must also consider qualitative factors such as neighborhood priorities, land-use trends, and public feedback. The result is a service plan that balances coverage, frequency, cost, and reliability.

The primary data factors used in service and route planning include:

- Demographics – Population density, income distribution, car ownership, and age profiles can help identify likely transit users.
- Land use – The location of homes, jobs, schools, shopping centers, major employment centers, and sports and entertainment venues determines potential origins and destinations. Area zoning and significant future regional plans for infrastructure and commercial development are also important.
- Travel patterns – Existing ridership data, traffic counts, and origin-destination surveys reveal how people currently move within the region.
- Equity considerations – Under the Title VI requirements of the U.S. Federal Transit Administration (FTA), agencies must ensure that service changes do not disproportionately impact minority or low-income communities.

The breadth, depth and accuracy of these data elements have never been better or easier to obtain. Copious amounts of demographic data exist in public databases at local, regional, state and national levels. Automatic Passenger Counters (APCs), Automatic Vehicle Location (AVL) data, cell phone data analytics and other tools provide travel pattern data that was unavailable just a few years ago.

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Community feedback (through avenues such as citizens advisory panels, customer surveys, etc.), input from regional leaders and the governing body of the transit agency also contribute to the reservoir of information that goes into the development of service plans and routes.

Like all forward-looking models, forecasting future transit demand is part science, part art. While models can predict future ridership with reasonable accuracy, planners must interpret the results of these models within a broader context – such as how future changes in fuel prices, telecommuting trends, redevelopment zones, neighborhood gentrification or new housing developments, etc. may increase or shift that future demand for transit services.

Once transit needs are identified, the next step is designing the system, network and routes that will best serve them. This includes the type of network the agency will use (i.e. hub and spoke, grid, etc.); the mix of services between Bus, Light Rail, Commuter Rail, Microtransit, etc.; and route design.

Route design is a balancing act between coverage (serving as many people and as many destinations as possible and no ‘service deserts exist), equity (making sure that the benefits of transit are distributed fairly) and efficiency (keeping routes as cost-effective as possible). Some of the factors that influence route design include:

- Population Density and Land Use – Routes are most efficient in dense areas where potential ridership is high. Planners analyze housing and employment density to determine the most productive corridors.
 - In dense urban cores, short, high-frequency routes may circulate between job centers and residential neighborhoods.
 - In suburban or rural areas, longer routes may connect key nodes, such as downtowns, schools, or shopping centers, with less frequent service.
- Economic and Activity Centers – Routes are typically anchored around major trip generators such as: major employment centers and retail developments, universities, hospitals and medical centers, sports and entertainment venues, etc. Aligning service with these destinations maximizes ridership potential.
- Street Network and Infrastructure – The physical layout of streets determines where buses can operate. Narrow streets, low bridges, or turning radius may restrict vehicle types or route alignments. For rail and other fixed guideway modes of service, topography, right-of-way availability, infrastructure costs and funding availability also play a major role in determining where these services will be located.

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- Travel Demand and Trip Patterns – Routes are designed to match observed travel behavior – commuting flows, school trips, or intercity connections. Data from smartcards and GPS tracking help identify “desire lines,” or the most common travel paths, which guide route creation or modification.
- Equity and Accessibility – Planners must also consider social goals, ensuring that low-income neighborhoods, senior centers, and areas with limited automobile access receive adequate service.

Another part of the art involves putting together the right mix of route types to best meet the identified demand, including:

- Local Routes – Local routes typically serve short-moderate distance trips and provide access to residential areas, schools, shopping centers, and other community destinations. Local routes have frequent stops, as frequent as every block or two if requested by patrons.
- Express Routes – Express routes are longer routes and generally provide service between suburban areas and major employment centers. They often include freeway travel for some portion of the trip. Express service is a limited-stop service, often only stopping at major transfer points, park-and-ride lots, or key destinations like downtown or other major employment centers. As such, Express routes are generally geared toward commuters and are usually peak-intensive. The freeway use and limited stops result in a faster service than other types of routes.
- Crosstown Routes – Crosstown routes operate across a city or region without entering downtown, connecting multiple local or radial routes at transfer points. They operate along peripheral or circumferential corridors and try to reduce travel time for those patrons who don’t need to go to the central business district.
- Feeder/Distributor Routes – Feeder and distributor routes are designed to connect local neighborhoods to major transit hubs (rail stations, bus rapid transit corridors, etc.) or trunk lines. They are normally short and run in a coordinated schedule with the rail or trunk line that they feed.
- Flex Routes – Flex routes combine features of fixed-route and demand-response service. They follow a general route and schedule but can deviate within a defined area to pick up or drop off passengers upon request. They generally serve low-density and/or low transit-demand areas.
- Rapid/Limited Stop Routes – Rapid/Limited stop routes are a hybrid between local and express services. They only stop at major intersections or transfer points along a corridor.

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System Parameters

There are multiple system parameters and calculations that are used to generate bus and rail schedules. These include:

Passenger Load Standards – What does your agency consider a full load on a bus or train car? What is the maximum tolerance for standing passengers during the busiest times of the day? This is stated in terms of a percentage of seats on the vehicle. And you may have different policies for bus and rail.

For example, if your agency's passenger load standard is 120% for bus and 150% for rail, that means on a 50-seat bus, the maximum load would be 60 passengers (50 seats x 120%) and 150 for a 100-seat rail car (100 * 150%). Note this is a planning parameter, not an in-practice maximum. As the actual service is delivered over months and years, if actual passenger loads regularly exceed that standard, additional vehicles may need to be added to that route.

Determine Peak Demand - Determined by taking actual counts of ridership at maximum load points on any line or route (or forecasted ridership in the absence of actual data or based on an anticipated significant change to service demand), considering the direction of peak travel.

Determine Desired Headways – Based on the Passenger Load Factor Standards, the Peak Demand and the various demographic information gathered above, you will need to determine headways, particularly for fixed guideway and primary, or trunk routes.

Headway is another term for frequency. How many minutes will there be between each vehicle? And headways need to be determined for multiple day types (weekday, Saturday, Sunday) and time periods (usually just peak and off peak, but midday might vary from early morning and late night). The headways for these key routes will help determine headways for the rest of the system, ensuring timely connections where appropriate.

For example, if your agency had 4 trains per hour passing a particular station, you would be running 15-minute headways.

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Learning objective: Identify the criteria that go into the development of bus routes.

Review Questions

1. Which of the following is a source of data or input that would be used in the Service Planning process?
 - a. Population and demographics
 - b. Current street network
 - c. The future site of a new sports complex
 - d. All of the above
2. Which of the following is not a major bus route category:
 - a. Local Route
 - b. Median Route
 - c. Flex Route
 - d. Express Route

Answers

1. The correct answer is D. All of the information in answers A – C would be used in the service planning process.
2. The correct answer is B. A Median Route is not a major Bus Route category.

Once service planning is complete, service scheduling can begin.

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SERVICE SCHEDULING

In this section, we will explain the basic concepts and route types used in scheduling.

Once a transit system's service goals and routes have been established in the service planning process, the next major step is turning those plans into a workable operating schedule. Scheduling involves determining exactly when vehicles will arrive and depart, how frequently they will run, and how much service will be required to meet service demand.

Scheduling forms the bridge between the theoretical planning world and real-world daily operations. It refines service design ("We need a local route between this cluster of multi-family housing and downtown.") into timed trips a passenger can rely on. Every decision in scheduling has consequences for how many vehicles or operators are needed, how much fuel or power is consumed, how crowded a vehicle may be, and how much it will cost the agency to provide the service.

Scheduling is the process of determining:

- Service period structure – typically broken into AM peak, midday base, PM peak, evening, and weekend patterns.
- Trip timing – the exact departure and arrival times for each stop on each route.
- Headways – how often service runs at different times of day.
- Coordination of transfers between different routes and modes – Arrangement for efficient transfers of passengers between vehicles.

In refining the service, schedulers must account for:

- Travel times under different traffic conditions – A route that takes one hour during the rush hours may only take 45 minutes in the midday.
- Passenger boarding/alighting durations – A route that you can drive in your car in 30 minutes will take longer when driving a bus because of the time required to stop to pick up and drop off passengers. Routes with more stops and heavier ridership will show a larger differential between automobile drive time and the bus schedule.

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- Recovery time ("layovers") to absorb delays – not every trip on a route is going to run in exactly the same amount of time, day after day, week after week. Any number of variables might affect run time: traffic, number of pickups and drop-offs, accidents, construction, weather, etc. Including a recovery period at the end of the line helps the system stay on schedule for the rest of the day. If not for these layovers, if a bus route fell behind schedule early in the day, it would likely be behind schedule the rest of the day. Or worse, the operator might be tempted to drive in an unsafe manner to try to catch up to the schedule. The more variability in runtime that there is on the actual run time of a particular trip, the longer recovery time you will need at the end of that trip.
- Limited vehicle fleet availability – The schedule can't call for more vehicles than the agency has available for service, including the allowance for operating spares and the reserve fleet.
- Coordination of route timing to ensure rider-friendly transfers – In locations where significant transfer activity occurs, routes must be designed to facilitate those transfers.
- Efficiency and consistency for customers – Schedules must be built in an efficient manner so that customers ride times and wait times are minimized and they must be built realistically so that customers can count on their bus being at their stop at the same time every day.

Peak and Off-Peak Scheduling

Public transit demand is highly time-dependent:

- Peak hours – Peak hours generally have the strongest ridership and highest vehicle frequencies of the day and occur during morning and evening commutes. They are roughly 6:00 – 9:00 AM and 3:30 – 6:30 PM. A busy urban route may operate buses every 15 minutes during peak periods, shifting to every 30 minutes during off-peak hours.
- Off-peak – Off-peak hours are early morning (before the AM peak), mid-day, and evenings after the PM peak has passed. These periods usually have moderate ridership compared to the peak hours. An exception to this might be a route that primarily serves and entertainment venue. A route like that might have more ridership during evenings when a concert or sporting event is scheduled.
- Weekends – Ridership on weekends are less structured and more driven by social and leisure trips. As such, weekend ridership is much more dispersed throughout the service day.

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Schedulers adjust service frequency, train consists (the number of rail cars that make up a particular train), and bus assignments to match these variations. The aim is to balance operational efficiency with passenger convenience. Too much frequency wastes resources; too little produces overcrowding and rider dissatisfaction.

Scheduling for Transfers

Arrangement of efficient, effective transfers may be the most difficult task in the transit scheduling. Scheduling a bus route from Point A to Point B is easy enough (relatively!).

But imagine that the route includes a stop at a rail station. The bus schedule must coordinate with the rail schedule. It should arrive ahead of the train, allowing passengers sufficient time to deboard the bus and make the transfer from the bus to the train. The bus should also “dwell” at the station in order to take on passengers from the train who are transferring to the bus route.

Imagine this route also interfaces with another bus route at a different location. If there is any change to running time or scheduled dwell time, it may negatively impact the transfer with the train or the other bus route. Because every schedule change affects transfer timing, and there are likely multiple routes with multiple transfer points in the system, every one of these changes ripples throughout the entire the network of routes in the system.

It’s like grabbing one branch of a tree (one bus route) and giving it a shake (change route timing). When you do that, the whole tree (the whole transit network) shakes.

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Learning objective: Explain the basic concepts and route types used in scheduling.

Review Questions

1. Why are recovery times built into schedules:
 - a. Allows the vehicle to refuel
 - b. Helps keep the route on-schedule for the rest of the day
 - c. Provide the operator with a meal break
 - d. Provide time for a mechanic to check the vehicle
2. When is peak service most likely to occur?
 - a. Evenings
 - b. Midday
 - c. Weekends
 - d. AM and PM rush hours

Answers

1. The correct answer is B. Recovery time is a short (usually just a few minutes) break that, in case the previous trip was running late, allows for the next trip to still be on time.
2. The correct answer is D. Generally peak service aligns with rush hours; generally, 6 AM – 9 AM and 3 PM – 6 PM.

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BLOCKING

In this section, we will define how routes are blocked to create vehicle assignments.

Before we get into the specifics of Blocking, you should be aware several terms:

Revenue service – Revenue service is defined as the time during the block when the vehicle is available to transport passengers. Revenue service may include short (a few minutes) recovery time at the end of a run but does not include any significant breaks (for example the midday meal break shown in the block below).

Deadhead – Unless a route begins at the garage or rail operating facility, the vehicle must travel from the garage to the point where revenue service begins. This travel is called deadhead. Deadhead also applies to the travel from the point where revenue service ends and the vehicle travels back to the garage, or in a situation where a vehicle moves, not in revenue service, to reposition for the start of the next trip. This may happen on an interlined route (discussed below).

Blocking organizes individual scheduled trips into vehicle-level assignments (blocks) that a single bus or train consist will operate over the course of a day. Whereas the schedule defines the service for passengers, blocking defines the service for equipment. Stated differently, the schedule is what the public sees, the block is how the agency delivers that service. Together, scheduling and blocking are key to efficiency, resource optimization, and effective service delivery.

The goals of the blocking process are to:

- Minimize deadhead
- Connect trips logically and geographically
- Maximize productive in-service time
- Efficiently utilize vehicle and financial resources

Below is an example of a bus block:

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Time	Activity
5:30 AM	Leave garage, deadhead to Route 1 origin
5:50 AM	Begin revenue service on Route 1
11:30 AM	Midday layover (out of service)
12:00 PM	Return to service
7:10 PM	End revenue service on Route 1
7:30 PM	Return to garage (deadhead)

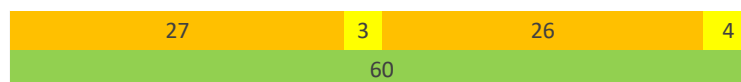
This is a 14-hour block (time from pull-out to pull-in) and includes 12 hours and 50 minutes of revenue service (14 hours less 40 minutes of deadhead time and 30 minutes out-of-service time during the midday).

Once the service has been blocked, the peak vehicle and spare vehicle requirements can be calculated. Efficient blocking is important because reducing peak vehicles by even one bus can save hundreds of thousands of dollars annually in operating and capital costs.

Rail blocking also includes the additional complexities of train consists (how many cars per train), track availability and yard movement and storage constraints. Unlike with a bus, you can't just pull a rail car out into the street if you need to reposition it in the yard or at the maintenance facility!

Here are several examples of runs, how they might be accommodated into a block of service.

This is a cycle time chart for a fictional Route 1 that runs back and forth from Point A to Point B. Orange represents running time, yellow for recovery/layover time and green for the total cycle time.



Or, if you prefer, here is a table view:

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Running time from A to B	27 minutes
Running time from B to A	26 minutes
Running time total	<u>53 minutes</u>
Layover at Point B	3 minutes
<u>Layover at Point A</u>	<u>4 minutes</u>
Total cycle time	60 minutes

Calculating the number of vehicles required for this route at various headways:

- If headway on this route is 60 minutes, 1 vehicle is needed
- If headway is 30 minutes, 2 vehicles are needed
- If headway is 15 minutes, 4 vehicles are needed

Using the trip above as an example, the following block can be created:

Time	Activity
5:30 AM	Leave garage
5:45 AM	Begin revenue service at Point A
5:45 AM – 7:41 PM	Complete 14 round trips
7:41 PM	End revenue service at Point A
7:56 PM	Return to garage

Challenge: If the cycle time is 60 minutes and the first cycle begins at 5:45 AM, why does the last cycle conclude at 7:41 PM and not 7:45 PM?

Answer: Once the bus has completed the 14th round trip, there is no need to use the 4-minute recovery time at Point A. As soon as the bus drops off the last passenger, it can head straight back to the garage.

Calculating the efficiency of this block:

- Total block time = 14:26 hours (14.43 in decimal notation)
- Revenue service time = 13:56 hours (13.93)
- Non-revenue (deadhead) = 30 minutes
- Efficiency is $13.93 / 14.43 = 96.5\%$, which would be pretty good!

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Now obviously one operator won't be operating this entire 14.5-hour block. That's where runcutting comes in!

Interlined Routes

Sometimes, for efficiency of operations, routes may be interlined. What this means is that a particular bus may not be on the same route all day. Maybe this bus operates one route during the peak but a different route in the off-peak. An interlined block might look something like this:

Time	Activity
5:30 AM	Leave garage, deadhead to route origin
5:50 AM	Begin revenue service on Route 15
6:50 AM	Complete AM round trip 1 on Route 15
7:50 AM	Complete AM round trip 2 on Route 15
8:50 AM	Complete AM round trip 3 on Route 15
	Switch to route 225
9:00 AM - 3:20 PM	Complete thirteen 30-minute round trips on Route 255
	Return to route 15
4:20 PM	Complete PM round trip 1 on Route 15
5:20 PM	Complete PM round trip 2 on Route 15
6:20 PM	Complete PM round trip 3 on Route 15
	Complete PM round trip 4 on Route 15 -
7:20 PM	End revenue service
7:40 PM	Return to garage (deadhead)

Calculating Vehicle Requirements

Calculating vehicle requirements is a multi-step process, starting with determining Peak Vehicle Requirements per Route, aggregating all routes to determine the Total In-Service Vehicle Requirement, and finally determining the size of the Reserve Vehicle Fleet(s).

Peak Vehicle Requirements per Route – For each route, you will need to calculate the vehicle requirements based on route duration and headways.

Let's use the block above as an example. Route 15 has a 60-minute cycle time during the peak; 30 minutes in each direction. If this route has 15-minute headways, then four peak vehicles would be required:

60 minutes for a round trip / 15-minute headway = 4 vehicles.

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Calculate Total In-Service Vehicle Requirements for all Routes – Once the peak vehicle requirements have been calculated for each route, the total for all routes will be your system total peak vehicle requirement. This is also known as the Vehicles Operated in Maximum Service (VOMS).

Calculate Reserve Vehicle Fleet Requirements – The Reserve Vehicle Fleet has two components; the Operating Spare Ratio and the Strategic Reserve.

- The Operating Spare Ratio is usually set between 10% and 20% of VOMS. The operating spares are kept in active status, and they are used to ensure the availability of service for day-to-day operations. These vehicles are rotated in and out of service based on scheduled and unscheduled maintenance on other vehicles in the fleet, and other minor service disruptions such as accidents or breakdowns during service.

They may also be used to create a 'Bus Bridge' in cases where there is a service interruption in a fixed route service (e.g. rail, etc.). In such cases, spare buses will be used to shuttle riders from a rail station before the point of disruption to a rail station on the other side of the outage, 'bridging' that gap in the rail service.

Factors affecting the size of the reserve fleet include considerations such as:

- Fleet age/reliability – older fleets are more prone to unexpected breakdowns and might require a higher spare ratio.
 - Mixed fleet types – if your agency has multiple different sizes and/or types of vehicles operating on different routes, that could require a higher spare ratio than a single homogenous fleet.
 - Maintenance capacity – if an agency has limited maintenance capacity, a 'blip' in vehicle reliability might cause a maintenance backlog resulting in the need for more spare vehicles to meet operational needs.
 - Financial constraints – how much money does the agency have to invest in vehicles?
 - Regulatory constraints – Some federal regulations, such as the Federal Transit Administration's cap of an agency's spare ratio at 20%.
- The Strategic Reserve, also called the Contingency Fleet, are generally vehicles that are older, often having exceeded their expected useful lives. They are kept in an 'inactive' status but in a state of readiness. They are placed into service in cases of emergencies or other events impacting service beyond the typical, daily issues such as natural disasters, extended construction that significantly impacts operations or perhaps major planned events (e.g. hosting the World Cup) that require significant increase in regional transportation needs for a relatively short period of time.

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Note: Some agencies do not differentiate between operational spares and the strategic reserve fleet.

Learning objective: Define how routes are blocked to create vehicle assignments.

Review Questions

1. Revenue service time is:
 - a. The total time between when a vehicle pulls out of the garage and pulls back into the garage.
 - b. The time between the first stop where the vehicle might pick up a passenger and the last stop where the vehicle might drop off a passenger.
 - c. The time between leaving the garage/rail yard and the first passenger pick up of the day.
 - d. The time between the end of one trip and the beginning on another.
2. Which of the following is the best definition of Blocking?
 - a. Blocking defines the use of vehicles in performing the service.
 - b. Blocking is the parking arrangement of vehicles at the bus garage or rail yard.
 - c. Blocking is the pre-arranged lineup of vehicles at a transit center or rail station
 - d. None of the above

Answers

1. The correct answer is B. Revenue service is the time that the vehicle is available for transporting passengers. It excludes deadhead time and any significant breaks during the day.
2. The correct answer is A. Blocking matches the vehicle schedule to the service schedule that the public sees.

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RUNCUTTING

In this section, we will describe the considerations involved in creating runs for operators through runcutting.

In the interlined blocking example above, a bus was in continuous service for more than 14 hours. Obviously, one operator will not run the whole shift due to fatigue, safety concerns, etc. This where runcutting comes in. Runcutting cuts blocks of service into operator assignments. What blocking is for vehicles, runcutting is for operators.

There are also a variety of labor laws and other restrictions and work rules based on collective bargaining agreements. These restrictions govern such subjects as maximum hours per shift, guaranteed minimum pay hours, required rest and meal breaks, etc. that must be accommodated when building the run cut.

The goal of Runcutting is to put together runs in such a way as to maximize the time an operator is in revenue service for the fewest dollars, while complying with all regulatory and collectively bargained restrictions.

However, every run has an unavoidable portion of non-revenue, non-productive time. These non-productive portions of the run are called "collaterals". This is in contrast to the time that an operator spends in the seat operating the vehicle, which is called "platform time."

Embedded in the collectively bargained work rules are provisions for different kinds of premiums and allowances that impact how the work is performed and how the operator gets paid. Examples of this include:

- Report time allowance – This is an allowance for the time between when the operator checks in at the garage and the time of the pull-out. It includes time to receive their vehicle assignment, and the inspection and make-ready of their vehicle. It might also include additional information on traffic or weather conditions, or other circumstances that might impact that day's operations. This allowance is typically 10-15 minutes.
- Turn-in allowance – This is the opposite of Report Time. It is the time allowed from the time the operator pulls into the garage until the time the operator is "off-the-

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clock.” It represents the time required to park the bus in its assigned space and walk back to the garage office to clock out.

- Guarantee time – Guarantee time provide a minimum amount of time that an operator will get paid for performing their duties. This can either be in the form of a daily value or a weekly value. Not all runs may total up to 40 hours of work for the week. In this case, the minimum guarantee kicks in to make sure they get paid for at least 40 hours (or perhaps 8 hours for the day).
- Shift Premium – Weekend work and late-night work are not as desirable as working weekday during the day, or ‘normal hours’. As such, the operator may receive additional compensation for working that undesirable shift. The premium may be in the range of 5% - 15%.
- Spread Premium – Speaking of undesirable work, since most transit agencies provide more service between 6-9 AM and 3-6 PM, there are some runs that require the operator to work the morning peak, not work in the midday and work again during the afternoon peak. This ‘spread’ is calculated from the report time in the morning to the scheduled end time in the afternoon or evening. The agency may ‘allow’ a differential of 10 hours between the start and end of a shift before additional compensation is given. If this spread is exceeded, the operator will earn a shift premium of, for example, 50%.

For example, if a given run requires check-in a 6 AM and check-out at 7 PM, the total spread of the run is 13 hours. In this case, the operator will be paid 50% of their hourly rate for 3 hours (13-hour spread minus the 10-hour maximum allowable spread) even though they are not working. The spread premium would be calculated as follows:

$$3\text{-hour spread premium} \times \$30/\text{hour} \times 50\% \text{ spread premium} = \$45.$$

Runs are categorized into three primary types that comprise most of the work assignments.

- Straight runs consist of one continuous piece of work, totaling approximately 8 hours, including any required relief and/or meal breaks. The following display is an example of a straight run. Note: Times are expressed as hours:minutes, not in decimals.

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	:10	Report Allowance
	:20	Pull-out deadhead
Platform time	6:55	Revenue time
	:25	Pull-in deadhead
	:05	Turn-in allowance
	7:55	Platform plus collaterals
	:05	Guarantee time
	8:00	Pay hours

- Split runs consist of two or three pieces of a block totaling approximately 8 hours with an unpaid break between pieces, called a 'swing'. A split run may look something like this:

	:10	Report Allowance, first segment
	:20	Pull-out deadhead
Platform time, first segment	2:55	Revenue time
	:25	Pull-in deadhead
	:05	Turn-in allowance, first segment
Swing	3:00	
	:10	Report Allowance, second segment
	:15	Pull-out deadhead
Platform time, second segment	3:45	Revenue time
	:20	Pull-in deadhead
	:05	Turn-in allowance, second segment
	8:30	Platform plus collaterals
	2:15	Spread premium (11:30 – 10:00) x 50%
	10:45	Pay hours

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- Extraboard is a work assignment used to fill in for absences, missed trips and fill-ins. Extraboard assignments might be 20-25% of work assignments. Sometimes an extraboard operator will come to work and not know what their assignment will be because they end up filling in for an operator who called in sick. Sometimes an extraboard operator may not even get an assignment for the day and will get paid just for being available that day.

Some additional, less frequent run types include:

- Relief run – This is a work assignment that provides relief to other drivers in the middle of their runs for meals, etc.
- Tripper – This is a one-trip run, usually during peak hours, that just doesn't fit cleanly into a full run. It is usually either run by an extraboard or part-time operator as opposed to creating additional split runs.
- Peak-only – Similar to a tripper run, but a longer piece of work, a Peak-Only run may be a 2-4-hour piece of work that is just in the AM peak or just in the PM peak. Like Trippers above, it is usually either run by an extraboard or part-time operator.

Mark-ups

Most agencies will do 2-3 run cuts per year, timed to go into effect with service changes where possible. Once the runs have been cut, drivers participate in a mark-up process (also called bidding) to select the runs they want to work for that mark-up period. This is usually done in seniority order.

Pay-to-Platform ratios

The ratio of pay-to-platform (also known as PTP) is a key operating statistic for transit agencies that measures efficiency. It's pretty self-explanatory. It's the ratio between Pay hours and platform hours. Because of the non-productive time built in, pay-to-platform ratio is always greater than 1. In the straight run example above, 8 pay hours is divided by the 7.40 platform hours (total time of 8 hours less report time of 10 minutes, turn-in time of 5 minutes and guarantee time of 5 minutes) or $8/7.67 = 1.04$.

But why does the header say "ratios" and not "ratio"? Because there are actually two calculations. The first one, illustrated above, compares hours to hours. The second calculation is pay dollars to platform dollars. These calculations will be different because not all hours are paid at the same rate. Some routes have a shift premium or exceed 8 hours and therefore a portion of the hours are paid at overtime. Additionally, operators

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are paid different wages based on seniority which also leads to a difference in the calculations.

The Pay-to-Platform Hours calculation is used to judge the efficiency of the run cut, independent of wage differences.

The Pay-to-Platform Dollars calculation is used in budgeting and budget variance analysis, and is also used to analyze cost efficiency.

Platform-to-revenue service ratio

Another useful analytical tool is Platform-to-revenue service ratio. This ratio is calculated by taking the total platform time in minutes, 7:40 (460 minutes) in the straight run example above and dividing it by the total revenue service time 6:55 (415 minutes) for a ratio of 1.11.

Learning objective: Describe the considerations involved in creating runs for operators through runcutting.

Review Questions

1. Which of the following is one of the most common work assignments?
 - a. Tripper
 - b. Relief
 - c. Split
 - d. Peak-only
2. What does the Pay-to-Platform ratio, when expressed in hours, measure?
 - a. The effectiveness of the service.
 - b. The efficiency of the service.
 - c. Budget variance.
 - d. None of the above.

Answers

1. The correct answer is C. Straight Runs, Split Runs and Extraboard are the three most common work assignments.
2. The correct answer is B. Pay-to-Platform is a measure of efficiency, not effectiveness.

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CONCLUSION

Congratulations! You have completed the **Bus and Rail Planning and Scheduling** module. You should now know how to:

- Discuss critical success factors in public transit
- Identify the criteria that go into the development of bus routes
- Explain the basic concepts and route types used in scheduling
- Define how routes are blocked to create vehicle assignments
- Describe the considerations involved in creating runs for operators through runcutting

For further information, review the remaining modules in the TFLEEx website www.TFLEEx.org, and the information under “Additional Resources.”

Final Knowledge Test

TFLEEx members will earn 1.0 CPE credit upon successfully completing a knowledge test (qualified assessment) for this module. Upon gaining an understanding of the material in this work and completing the review questions, contact Joe Costello, TFLEEx Executive Director, at CostelloConsultingCorporation@gmail.com. He will provide you with a **final knowledge test**. You will have 30 days to send your answers to Mr. Costello. Upon answering at least 70% of these questions correctly, you will receive a certificate of completion for the 1.0 CPE credit, as well as evaluative feedback.

Not a member of TFLEEx? Please reach out to Joe Costello, TFLEEx Executive Director, at CostelloConsultingCorporation@gmail.com to find out how your agency can join. We encourage you to do so. We know you would get great value in being part of this organization!

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GLOSSARY

APCs: Automatic (or Automated) Passenger Counters.

AVL: Automatic Vehicle Location technology.

Blocking: The process of assigning vehicles to run the scheduled service.

Cycle Time: The length of time for a round trip on a route.

Deadhead: 1) Travel between the bus garage/rail facility until the start of revenue service, 2) Travel between the end of revenue service back to the garage/yard or 3) a non-revenue service move of a vehicle between the end of one trip and the start of another trip. Mostly seen on interlined routes

Extraboard: The Extraboard is a work assignment used to fill in for absences, missed trips and fill-ins.

FTA: Federal Transit Administration.

Guarantee time: Guarantee time provide a minimum amount of time that an operator will get paid for performing their duties. Guarantee time can be either on a per day or per week basis.

Headway: Frequency of service. A route that has four trips per hour has 15-minute headway.

Interlined Route: A block of service which includes operation on more than one route.

Mark-up/Bid process: The process by which operators choose their assignments.

Operating Spare Ratio: The vehicles over and above VOMS that are used to fill in for vehicles that are unavailable due to scheduled and unscheduled maintenance and other minor service disruptions.

Passenger Load Standard: A standard created by the transit agency as a goal for the maximum number of passengers per vehicle before additional service should be added.

Peak-only run: A small piece of work, but longer than a Tripper, usually just run in either the AM or PM peak that is often performed by a part-time operator.

Platform time: The amount of time the operator is actually in the seat driving the vehicle.

Platform-to-revenue service ratio: An efficiency metric comparing the amount of platform time to the amount of revenue service time.

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PTP: Pay-to-Platform ratios. Pay hours divided by platform hours. Also Pay dollars divided by platform dollars.

Recovery time/Layover: A short break at the end of the line to accommodate unexpected delays and keep the route on time during the day.

Relief Run: A work assignment that provides relief to other operators in the middle of their runs for meals, etc.

Report time allowance: This is an allowance for the time between when the operator checks in at the garage and the time of the pull-out.

Revenue Service: The period of time when a vehicle is available to transport passengers.

Runcutting: The process of assigning operators to run the scheduled service.

Service Planning: is the process of designing and optimizing a system of routes and services to meet a community's mobility needs.

Service Scheduling: The process of turning the Service Plan into a real-world schedule.

Shift Premium: Additional pay compensating operators for working off-hour, non-desirable shifts.

Split Run: A run that has two pieces of work (usually AM and PM peak) separated by a midday break.

Spread Premium: Additional pay compensating operators for working split runs.

Strategic Reserve/Contingency Fleet: Vehicles that are kept in an inactive status but are available to be placed into service in cases of emergencies or other events that would require extra transportation resources that are beyond normal day-to-day needs.

Train consist: How many rail cars make up a particular train.

Trippler: This is a one-trip run, usually during peak hours, that just doesn't fit cleanly into a full run.

Turn-in allowance: The opposite of Report Time. It is the time allowed from the time the operator pulls in to the garage until the time the operator is "off-the-clock."

VOMS: Vehicles Operated in Maximum Service.