PURPOSE-DRIVEN PUBLIC TRANSPORT: CREATING A CLEAR CONVERSATION ABOUT PUBLIC TRANSPORT GOALS

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Public transport exists for a range of purposes, including environmental, economic, and social ones. However, different purposes may imply quite different kinds of service. Public transport providers and funding agencies may try to present themselves as serving all the diverse purposes of public transport, but in fact they must make hard choices between competing goals. This paper presents a language for discussing these hard choices with constituents, one that has proven valuable in consultation and decision making.

Most of the purposes of public transport cluster around two opposing poles:

- Purposes served by *patronage*. Most environmental benefits of public transport are related to how many people use the service. Fiscal-conservative goals, such as minimizing subsidy, are affected by fare revenue, which also varies with patronage.
- Purposes served by *coverage*. Social benefits of public transport, such as accessibility for persons who cannot drive, tend to be based on the severity of need among certain population groups, rather than the level of patronage to be gained by meeting this need. Demands for "equity" of public transport service among areas with different patronage potential also can yield low-patronage services that are retained for these non-patronage reasons.

This paper contends that it is possible to create a language in which to discuss those hard choices with the public, so that elected leaders can make informed and quantified decisions about those choices that reflect their constituents' values. The key idea is to use the consultation process to educate constituents and decision-makers about the patronage-coverage tradeoff, and then elicit a direction in the form of a percentage of service resources to be devoted to each of these purposes. The role of the public transport funding agency and operator, in this scheme, is to document that the service they are providing reflects the particular tradeoff chosen by the public through their elected leaders.

A scheme of this kind was developed by the author in the course of consulting projects for several public transport agencies in North America.1 The agencies in question ranged from larger urban operators (population over 2 million) to agencies covering free-standing small cities (population 50,000-100,000). The techniques have somewhat different application in Australia, where State Governments typically fund public transport and operating companies provide it. However, these techniques can still have application in forming a clearer basis for understandings between governments, private operators, and local constituencies, about how

[1] The author acknowledges the contributions of these clients to this line of thinking, notably Salem Keizer Transit, Salem, Oregon; Whatcom Transportation Authority, Bellingham, Washington; and VIA Metropolitan Transit, San Antonio, Texas.

service design follows from value judgments articulated by elected officials on behalf of their constituents.

PATRONAGE GOALS

Broadly speaking, a patronage goal is one that is achieved to the extent that people use public transport. These goals include:

- Goals related to financial return or efficiency. Private operators in schemes where they receive the fare revenue are motivated to maximize patronage.
- Goals related to vehicle trip reduction. Most environmental purposes of public transport – including emissions reductions -- are met by full public transport vehicles and not by empty ones.

The typical measure of a patronage goal is patronage per unit of cost, e.g. passengers/km or passengers/hr. Where fare revenue is relatively constant per passenger, fare revenue per passenger (high) or subsidy per passenger (low) can also express achievements toward a patronage goal.

Patronage goals are not all exactly aligned with one another. For example, some emissions-related goals are related to vehicle km travelled, and are therefore met mostly in relation to passenger-kilometres. Others, especially those relating to "cold start" emissions, tend to vary with passengers more than passenger-distance, at least over the typical distance range of urban public transport operations. Meeting environmental goals may also require that public transport patronage consist of people who would otherwise have generated car trips, rather than those who otherwise would have walked, cycled, or not made the trip.

In the urban public transport context, however, these variations are small in comparison to the difference between patronage goals and their opposite, the coverage goals. The key point of patronage goals is that they all tend to lead to similar kinds of service, namely:

- *Frequent all-day service in dense areas*, typically inner cities built largely to two or more storeys such as Sydney's 'terrace zone.'
- *Frequent peak-period service in commute markets*, where a high level of demand can be served over a short period.

In most urban PT operations, the most productive services, in terms of patronage per unit of cost, are generally of these types.

COVERAGE GOALS

Coverage goals are met by the availability of service, regardless of its patronage. These values tend to include:

- *Social needs of disadvantaged populations.* When a public transport operator proposes to cut a service due to low patronage, the response is often an intense objection from small numbers of people who depend heavily on the service. A facility serving senior citizens or disabled persons, for example, will advocate for their service not based on how many people use it, but rather on the severity of the problems these people would face if the service were taken away. Whenever

service is provided or retained due to such appeals, we are in the presence of a coverage goal.

- *Concepts of geographic equity*. The perception that service should be "equitable" leads to a dispersion of service to include areas with low patronage potential. In outer-suburban Sydney, for example, typical "good" performance for a bus route can be as little as 0.5 passengers/km, while in the dense terrace zone a "good" performance is 2.0 passengers/km or more. A purely patronage-based approach would focus service on the best market and abandon unproductive markets. Services retained despite this consideration reflect the impact of the coverage goal.[2]

The typical measure of a coverage goal takes the form "___ % of residents and jobs must be within ___ metres of service."

Again, there are some subtleties among coverage goals, but they are exceptions that prove the rule, showing that all coverage goals are broadly more similar than different.

- Severity of need and geographic equity sometimes diverge in the case of very small numbers of people with severe needs in an otherwise rural setting, but the vagueness of the concept of equity is often extended to embrace these cases.
- Low-patronage service may be provided with the intent of "leading development," where there is credible reason to believe that high patronage will be achieved at development build-out. These cases are typically dealt with by identifying the service as patronage-based but defining the patronage target in relation to development completion.

Service designed for a coverage goal is by definition low-patronage service, by the standards of a given agency or service area. As a result, these services tend to be:

- devoted to low-density and rural areas where patronage potential is always relatively low
- infrequent, because services are spread over the largest possible area.
- circuitous, often including one-way loops, because covering an area is more important than speed or directness of operations.

Demand-responsive services are usually coverage services, the only exception being evening demand-responsive services that support an all-day high-patronage market by providing a "guaranteed ride home."

USES OF THE PATRONAGE-COVERAGE DISTINCTION

The question about how to divide resources between patronage and coverage services is a judgment about competing values. It obviously has no technical answer, but rather goes to the heart of each citizen's beliefs about why public transport should exist at all. Framing service design questions in these terms can quickly lead to remarkably clear conversations among constituents about what really matters to them.

This conversation can lead, in turn, to an informed decision by appropriate elected officials. The resulting policy typically takes this form:

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[2] Alternatively, equity can be as a possible position midway between patronage and coverage goals, as discussed later in the paper.

Devote ___% of resources to services justified by patronage, and the remaining ___% to maximizing coverage.

Service design professionals can design a network that implements this direction precisely, including documentation showing which services are intended for patronage and which are intended for coverage.

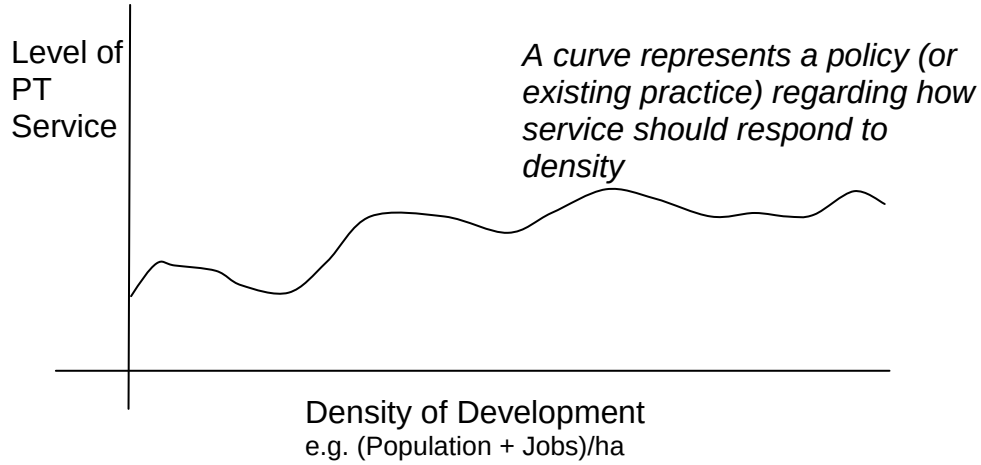
Such a policy provides a clear answer to inevitable objections that arise during consultation, by showing that the service provided is a fair implementation of a consistent policy. For example, if a resident of a low-density area complains about their low level of service, the reply is that:

- the density and/or development pattern where they live is not conducive to a high-patronage service, so any service they receive is going to be coverage service
- the proposed service plan represents a fair distribution of the __% of service dedicated to coverage over the areas to be covered.
- if you want more service than is provided, your options are to (a) advocate for a shift of the overall policy in favor of coverage or (b) advocate for a local funding source in your council or market area to supplement your service above the policy level.

Many elected officials value this kind of policy because it spares them from accusations of favoring one area over another. It also empowers the elected official by creating a clear separation between the value judgments of service design – which elected officials should make – and the technical and creative aspects which are the province of service design professionals. The result can be an increased level of trust between these two essential parties in the service design process.

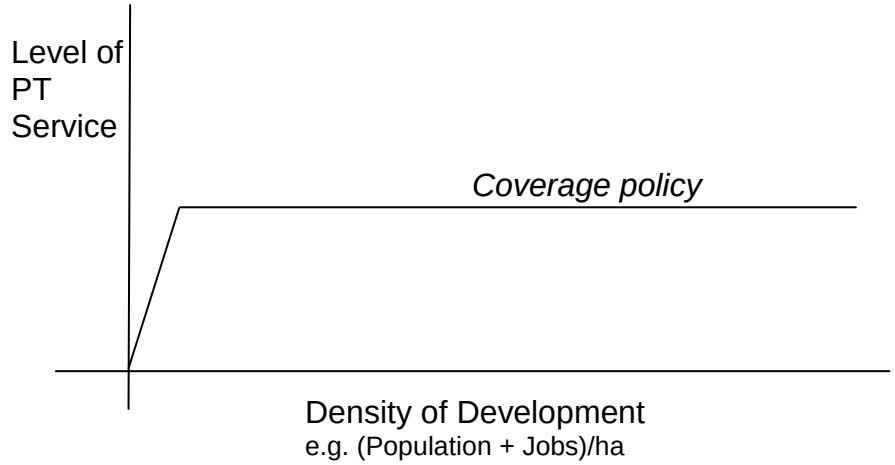
SERVICE ALLOCATION POLICIES AND "EQUITY"

To understand the effect of the productivity and coverage goals on service design, consider a service allocation graph where the x-axis represents density, and the y-axis represents the service provided. Different service allocation policies can be represented by different curves. If a hypothetical community had equal amounts of each density, then the area under the curve would be proportional to the overall quantity of service provided.



Density here should be understood as a shorthand term for "aspects of a built environment that directly affect public transport patronage." As Cervero3 and others note, density is indeed the overwhelmingly dominant indicator, but other aspects of design, such as the continuity of the pedestrian network, are also relevant. By the same principle, density must be understood as combining both population and activity density. The measure (Population + Jobs)/ha is a reasonable approximation that is easy to calculate, though subtler and more complex measures are possible.

A coverage approach is responsive to need rather than density. Even coverage-oriented service falls away at the very lowest densities, but apart from this coverage service is about making a little service available everywhere, regardless of density. For example, a typical small-city coverage system consists of one-way loop routes all running at the same frequency, converging on a center for the purposes of connections but otherwise offering the same level of service everywhere. A coverage policy, then, would be a horizontal line, falling away only where the level of activity is so close to zero that the community expresses no need for PT even as a social service or lifeline:



A deployment based on patronage is more complex, because the relationship between density and patronage has several different phases. Spillar and Rutherford4, for example, looked at cities in the Western US, with a range of densities commonly found in Australia, and found these relationships:

- In rural development up to about 12 dwelling units per hectare[5] (du/ha), demand is at a very low level, rising slowly in direct proportion to density. (Demand at this level is actually highly dependent on the presence of demographic categories with high public transport needs, such as senior citizens, the disabled, and youth below driving age.)
- From 12 du/ha to about 49 du/ha[6] demand rises faster than density, in an upward and roughly parabolic curve. This is the range in which most urban development in Australia occurs, outside of the densest urban cores.

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3 Cervero, Robert. 1998. *Transit Metropolis*, Island Press, 1998. p. 72-74

4 Spillar, Robert J., and G. Scott Rutherford. 1998. "The Effects of Population Density and Income on Per Capita Transit Ridership in Western American Cities." *Institute of Transportation Engineers' Compendium of Technical Papers*: 60th Annual Meeting. August 5-8, 1998. Pp. 327-331.

5 5 du/acre in Spillar and Rutherford

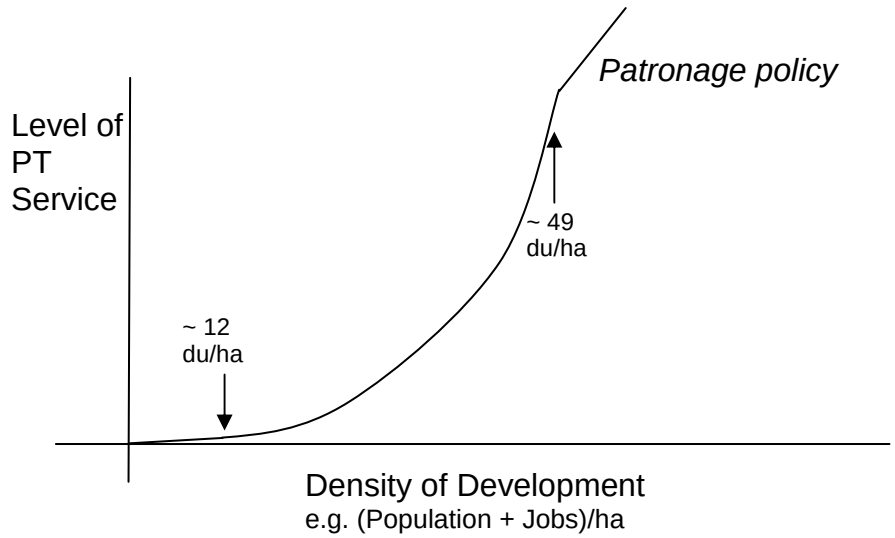
6 20 du/acre in Spillar and Rutherford.

- Above 49 du/ha demand is again linear with density, but at a much higher rate than in rural areas. At these high urban densities, people live so close to so many of their daily needs that walk trips begin to take a large mode share at the expense of PT.

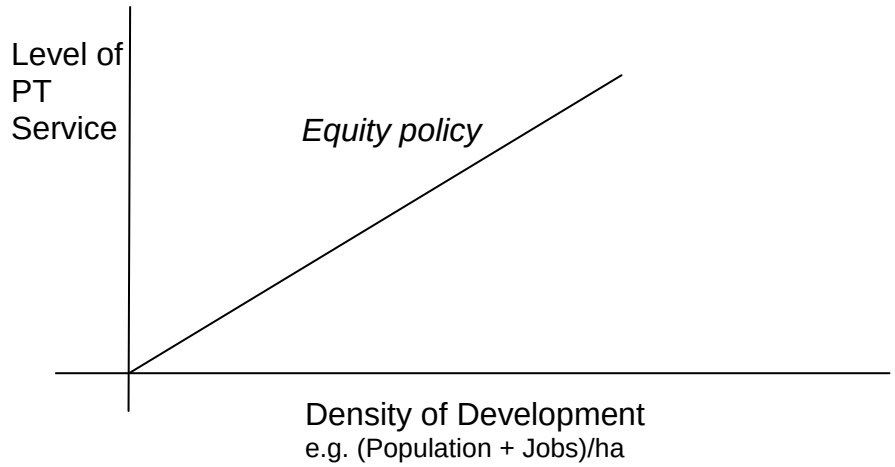
Given these relationships, a service pattern devoted to maximizing patronage would follow these phases with service. The goal of the patronage policy is to deploy all service where it will carry the most passengers overall. Thus:

- At densities below 12 du/ha, patronage potential is low except for the occasional school trip. Thus, a strict patronage policy would provide no service apart from those school trips.
- At densities of 12-49 du/ha, patronage potential rises faster than density, so a patronage policy would follow this rising curve. (Note that Spillar and Rutherford note that the rate of public transport use per household rises in an upward curve. The service allocation strategy, then, would be an even steeper curve, reflecting this rate of use times the number of households.)
- Above 49 du/ha, the curve becomes a steep line, as patronage continues to grow with population density, but not faster.

So a patronage policy would look something like this:



Graphing the policies in this way suggests a possible "compromise" between the two policies, namely one in which the service is directly proportional to the density throughout the range. This could be called an "equity policy," although it is not always what advocates of "equity" intend:



In regions or states where there is a wide range of development types, the equity policy has obvious appeal. Something like an equity policy is usually at work if an agency tolerates a much lower patronage/km in a low-density area than in a high-density area, as most state public transport authorities in Australia do. In very dense cities, however, the equity policy provides far less service than the patronage policy does. A common outcome may be overcrowding in dense inner city portions of a network, while in outer-suburban areas PT may run largely empty outside of school peak periods.

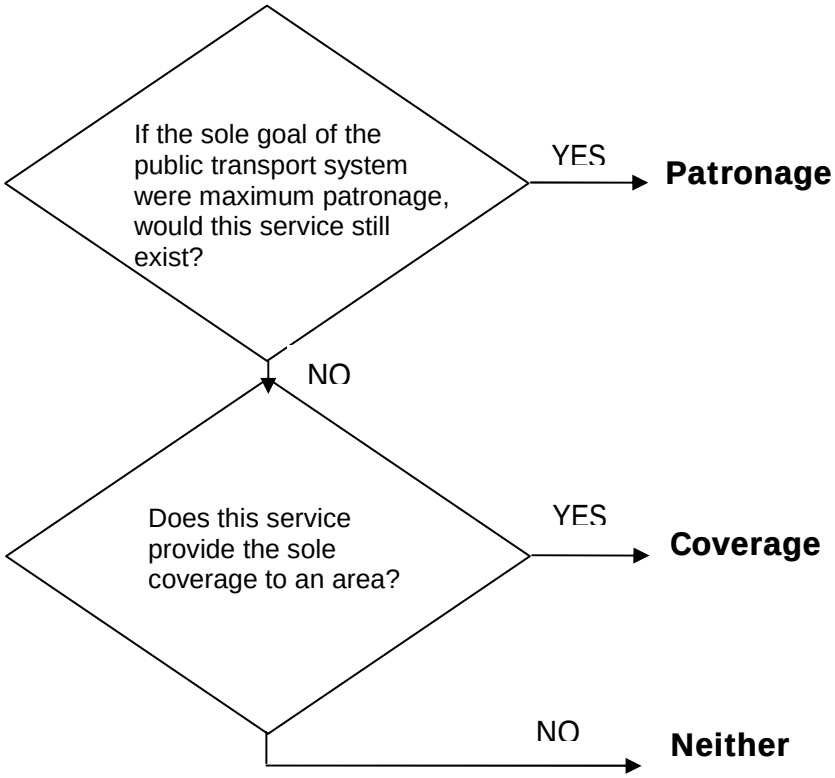
In practice, every consistent system of service allocation will be some compromise between a patronage policy and a coverage policy. The equity policy is one possible compromise, so long as policymakers are comfortable with having empty PT vehicles in outer suburbs and overcrowded ones in the inner city. A simpler form of compromise, however, is simply to allocate resources between patronage and coverage goals, and allow the resources on each side of the divide to be used unequivocally for that end. The remainder of this paper looks in more detail at how to use these terms in analysing and revising a network.

ANALYSING EXISTING SERVICES BY PURPOSE

A consultation process on the patronage-coverage tradeoff typically begins with an analysis of existing public transport services in these terms. This analysis categorizes services according to the purposes they seem to be serving. The analysis typically looks both at the current performance of each route or service, as well as features of its design and the degree to which its existence supports other services.

The decision process for this analysis is as follows:

For each service segment that can be isolated as a unit of cost:



The sequence of steps has an impact on the outcome. If a service is justified by both patronage and coverage, it's assigned to patronage. This could have been thought of the other way: We could have first identified a system wide network of coverage, and then assigned to patronage only the frequency increments above that level. Both methodologies are valid, but get different answers, so the point is to be consistent in which methodology is used. The reason to assign to patronage first is a practical one: Many routes fall entirely into, or out of, the patronage category, so analyzing the service this way means that fewer routes need to be divided between categories, and that routes can be divided by segment rather than by increments of frequency. The result is a simpler calculation and one that is easier to represent on maps.

The analysis is done primarily in terms of geographical segments, rather than temporal segments such as span of service or increments of frequency. There is an important philosophical reason for this: Temporal segments are much more interdependent than geographical segments are, and therefore harder to divide by purpose. Every customer's round trip requires service at two times of day, or more, and every trip is sensitive to wait time and hence frequency. Therefore, cutting any temporal piece of service -- e.g. by cutting off evening service earlier, starting morning service later, or reducing frequencies between the peaks -- will have effects on patronage on other times of day. For this reason, it's misleading to say that a certain part of a service span, or a certain increment of frequency, is attributable to patronage while the rest is not. By contrast, a geographical increment is much easier to analyze in isolation, because it represents a discrete market.

It would be easy to say, then, that the purposes of patronage or coverage are features of an entire route. However, it is quite common for an inner segment of a route to be justified by patronage, while outer tails or branches are clearly not. For this reason, some segmentation of routes may be essential for the analysis.

Assigning Segments to Patronage

The first question in the flowchart above may need some further explanation, because it's conditional and therefore requires considerable judgment. How do we know that a certain segment would be part of a maximum-patronage system, if that system were created and optimized?

The assignment is made based on the convergence of two factors:

- **Existing Patronage.** Segments assigned to patronage generally have an existing productivity (patronage per unit of service) that exceeds the system average. This must be based on the average load through the segment, not the boardings in the segment, since a non-stop segment where the bus is full is clearly patronage-justified.
- **Physical Evidence of Patronage Potential.** For segments where the existing load is not decisive either way, we consider whether the segment's physical features lend themselves to further patronage growth, based on industry experience. Thus, positive indications for patronage include:

    - Straight and direct (as opposed to circuitous and looping)
    - Operating on arterial streets that permit reasonable speed.
    - Serving continuous high-density development (i.e. a high population/employment level within 400 metres).
    - Good pedestrian access from 400 metres to either side.
    - Major patronage sources at the end of the corridor or segment, indicating demand to the end of the line.
    - A necessary part of a coherent connective network linking other high-patronage segments.

The "physical evidence" criteria tend to correlate with high patronage throughout the developed world. We include them because existing patronage on a particular local segment may be affected by other factors that are extraneous to this analysis. Where that's the case, it's important to consider whether the segment has the potential to be a high-patronage segment, and these factors are the definition of that potential.

Assigning Segments to Coverage, or to Some Other Purpose

If a segment clearly isn't justified by patronage, then we ask whether it has a unique function in providing the sole service to some neighbourhood or community. A good way to quantify this is: "If this service didn't exist, would a significant number of residents and/or jobs no longer be within 400 metres of service?"

The answer is usually yes, but the test is important because if the answer is no, the segment may have some other justification, usually but not always a weaker one. Examples may include:

- Overlap. A segment may exist overlapping other segments. This often occurs where service from several unique coverage areas converges on one path into a CBD or interchange. Small segments of this overlap may be acceptable in coverage services, since there is typically no more efficient route structure. Since at this stage of the analysis we are speaking only of low-patronage services, long segments of overlap may be an opportunity for service redesign to create a more

efficient pattern of coverage, possibly by introducing a connection in place of the long duplication.

- Political Discretion. Sometimes a service exists to satisfy a political demand, though it does not rise to the standards of either patronage or coverage. This is not necessarily a problem. Some applications of this scheme create a separate but usually small "Discretionary" category for these cases.

Where these categories exist, it is helpful to isolate them because they suggest other solutions. For example, when this analysis was done at Salem-Keizer Transit in Salem, Oregon, the quanitification of an Overlap category helped the policy board understand the costs of offering a service pattern that required nobody to change to reach the CBD, as opposed to other structures that would introduce more interchanges but reduce this duplication, thus allowing for better frequencies from the existing operating budget.

CONSULTATION PROCESS

Once an existing system is understood in terms of how it divides resources between patronage and coverage – and other purposes if relevant – elected officials are presented with a clear question that only they can answer: How should this balance between competing goods be shifted, if at all?

The best way to illustrate the question to decision-makers is to draft two or more service designs that illustrate different points on a spectrum. In several projects, the author has prepared two service designs, one emphasising patronage and the other emphasising coverage. Both designs were taken into consultation. This approach had several benefits:

First, the common complaint about consultations – that the plan has already been decided on and consultation is just a show – was refuted by the presentation of two options. All public transport management staff participating in the consultation were instructed to show no preference between the options in their comments to the public.

Second, all participants readily understood the philosophical choice underlying the difference between the two options. For participants who were not comfortable discussing patronage and coverage as abstractions, the contrast between the proposed networks made the tradeoff clear.

Finally, all participants could express an opinion that could be translated into a quantifiable 'vote.' For example, if one scenario was, say 60% patronage and 40% coverage7, while the other was the opposite, then participants could easily vote for one of these, or to say that they'd be comfortable halfway between them (a 50-50 split), or that they feel the split should be like one scenario but even more extreme (a 70-30 split or more). These votes could be readily tallied to quantify the position of any consultation group, thus providing clear guidance to the elected official(s) making the final decision.

In short, the analysis and discussion of a service plan in terms of a patronage-coverage tradeoff yielded a clear discussion in which all participants could have a valid opinion regardless of their technical expertise. Nobody needed to master technical details of a proposal in order to discuss it. Instead, participants understood that they were being asked a real and consequential question, and that their response would have a measurable effect on the

[7] Given obvious roughness in the way services are allocated to categories, participants are encouraged to think about the patronage-coverage split in 10% increments.

outcome. This clear conversation, and the clear and implementable policy resulting from it, is the ultimate purpose of the analysis.