

# TOWARDS A SERVICE ONTOLOGY TO DRIVE REQUIREMENTS FOR PUBLIC INFRASTRUCTURE AND ASSETS

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This paper presents the first steps in developing a service oriented framework to support sustainable investment in community assets and infrastructure, currently estimated to be worth \$170b in Australia [1]. The requirement for a service oriented framework is driven by the need for local communities to manage their renewal gap; the disparity that exist between existing services and the cost of maintaining them, against the funds available to do so. In particular, the cost associated with the assets that enable the services outcomes to be achieved. The paper explores the problem space and presents a research map that charts what we believe are the steps necessary to address the problem. We believe that the decision making processes surrounding the ongoing and future investment in assets should be driven by a process of community participation. The focus should be aligning the outcomes and benefits derived from the assets to the vision and goals set by the community. Best practice asset management frameworks frequently espouse the principle that ownership and management of assets should be driven by service needs. However, our research has shown there is very limited support for translating service needs into sustainable asset management. In most authorities responsible for managing community infrastructure there appears to be a disjoint between the service management and the asset management. In this paper we present a service ontology that helps bridge the gap, providing a framework for managing asset investment based on service outcomes that can be used consistently across different services.

key Words: service, ontology, investment, asset, management, requirements, community, local government, councils, service logic, renewal gap.

## 1 THE PROBLEM SPACE

The research reported in this paper is part of a broader program of work that seeks to create a service oriented framework to support sustainable investment in community assets and infrastructure. There are three core problems that are driving the need to undertake this research, namely:

- communities at risk of becoming disenfranchised by being excluded from the decision making processes that impact their future,
- community wellbeing threatened by poor investment decision in community services and enabling asset,
- a growing risk that community services will fail due to systemic inadequacies in government grants and their allocation mechanism.

Figure 1 is a research logic map that shows: the problem situation that is driving the need for this research; the strategic interventions we aim to achieve through this program; the benefits this will deliver to communities; the specific projects we will undertake to get there and the knowledge bases we will be building upon (or in some cases creating) to support the process.

Our goal is to provide a framework that will assist governments and communities in the collective decision making processes that determine the most efficacious use of the limited resources communities have to spend on developing, maintaining and modernising their infrastructure. We believe that our output should be a framework not a prescriptive process because local

governments (the principal authorities responsible for maintaining community infrastructure) are all unique with subtle yet important differences. Furthermore, we believe our approach should be systemic because of the interconnected interdependency of local government services.

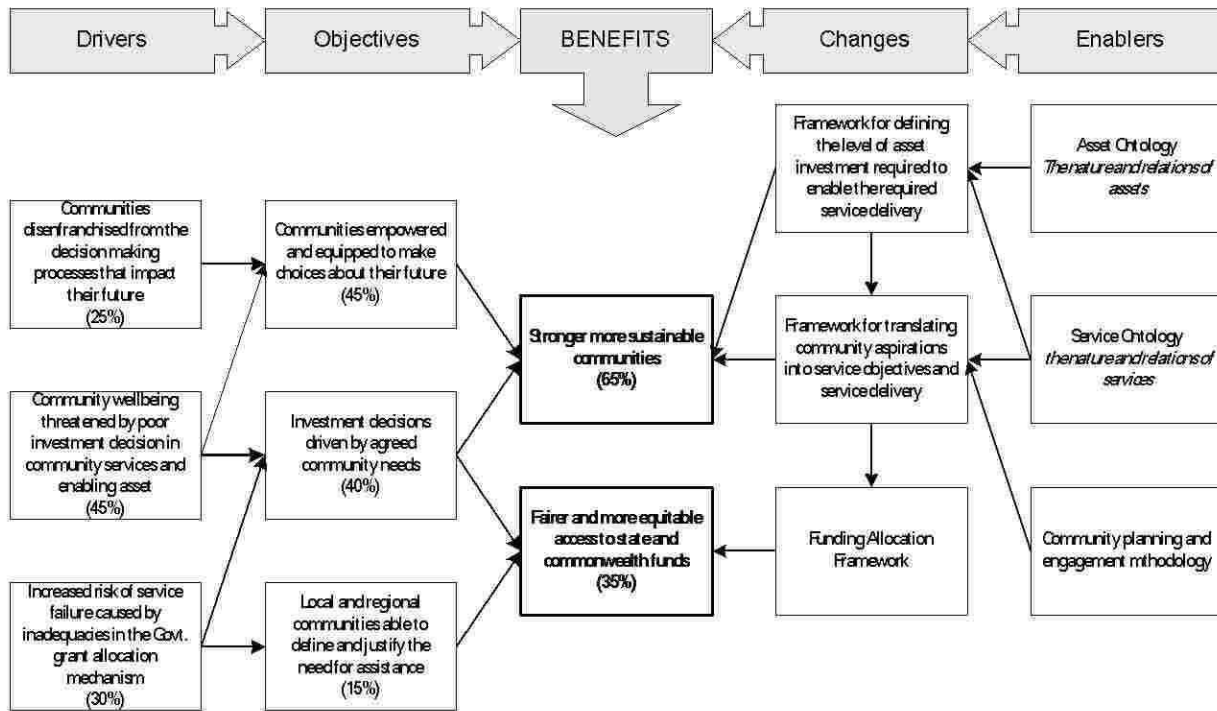


Figure 1. Research Logic Map for the Development of a Service Oriented Framework to Support Sustainable Investment in Community Infrastructure and Assets

### 1.1 Research Driver1, Disenfranchised Communities

Driver: *Communities disenfranchised from the decision making processes that impact their future*; we have assigned this a relative weighing of 25% of the problem space.

Across most Australian communities there is a disparity between the cost of continuing to provide services as we experience them today and the funds available to do so, referred to as the ‘renewal gap’. Evidence collected to-date demonstrates that the renewal gap is a major issue [2] that will require innovative solutions if we are to maintain sustainable services and infrastructure and help mitigate the burden being transferred to future generations.

Community infrastructure provides the service backbone to many communities, particularly in rural and regional Australia. The inability to maintain community halls, swimming pools, ovals, theatres, libraries, footpaths, walking trails and boat ramps, among many other assets, has significant impacts on the wellbeing and survival of communities. A failure to maintain these assets can have major implications for issues such as health and obesity.

It is not the purpose of this paper to discuss the root cause for the renewal gap; this has been adequately covered by others [3] who suggest that a major part of the problem relates back to the post war infrastructure boom that was largely resourced using state and commonwealth grants. Most of this infrastructure is rapidly approaching the end of its serviceable life[4].

Since the period when this infrastructure was initially developed there has been significant demographic and cultural change within Australian communities. Many community assets that were once seen as necessary no longer service the changing needs and in some instances are no longer required. Ultimately, the purpose of renewing and modernising assets is not to preserve them but to enable communities to achieve the vision and goals they believe are important. Within this context the debate about the renewal gap should not be restricted to a small subset of asset managers. Managing the renewal gap is an issue that goes to the heart of our aspirations for safe thriving and prosperous communities. Decisions about how we manage the gap must ultimately be driven by the communities.

For many communities the size of the renewal gap is significant and ultimately some compromises will have to be made. The decisions are not easy. In order to help drive more balanced and equitable outcomes there needs to be a level playing field from which one can holistically evaluate the benefits and consequences. The lack of a well-founded service ontology that can be consistently applied makes it very difficult to compare the benefits of one service with another. This compromises the ability to rationally allocate resources to the assets that enable these services.

Without the information and frameworks to enable community ownership and engagement in solving the problem the process becomes shrouded in mystery, ultimately being managed by the experts. At this point the community loses any sense of ownership in the outcomes and become disenfranchised from the decisions that ultimately help shape their future.

## **1.2 Research Driver2, Community Wellbeing Threatened**

Driver: *Community wellbeing threatened by poor investment decision in community services and enabling asset*, we have assigned this a relative weighting of 45% of the problem space.

Best practice asset management frameworks frequently espouse the principle that the ownership and management of assets should be driven by service needs [5]. Service delivery is not new to local government. However, service oriented governance structures and service centric cultures are relatively new. For many councils the structure, roles and responsibilities are still largely functional, built around well established functional silos. Under a functional silo model of government the principle of service driven asset management is often reduced to assigning a service level to the asset largely independent of the service they enable. In most instances these service levels default to a combination of form and functional performance of the asset. In a functionally structured organisation it can be difficult to redirect the focus of attention from the asset toward the outcome served by the asset as the structure does not accommodate the dialogue and reporting across organisational boundaries.

The danger we face is that the debate is focused on the asset or infrastructure and not the outcomes they enable the community to achieve. If the asset is disconnected from the service outcomes then there is increased potential that inappropriate investment decisions will be perpetuated.

Our conjecture is that the debate about infrastructure and assets should be driven by a dialogue with our communities about the service outcomes they want to see achieved; which ultimately derives from their aspirations; the vision and goals they have for their future. Without a well-founded service ontology that links these community aspirations to services outcomes and service outcomes to the enabling infrastructure and asset base, then we compromise our decision making capability. The risk is that we fund the development, maintenance and renewal of community infrastructure and assets because its "nice-to-have", without truly understanding the value it contributes towards the vision and goals of our community.

Community consultation is not new. However, we would challenge the adequacy of a consultation process that is focused on a single issue. Our conjecture is that the issues facing many communities require a systemic approach. It is only when one looks at the system as a whole that you are able to assess the merits of a particular service. The emotions and passions aroused when individual facilities are threatened can easily be distorted and detract from the development of a broader understanding of the value individual assets contribute to our community.

## **1.3 Research Driver3, Inadequate Funding**

Driver: *Increased risk of service failure caused by inadequacies in the Government grant allocation mechanism*, we have assigned this a relative weighting of 30% of the problem space.

The problem is at two levels; firstly, there may not be enough money being allocated and secondly, the money that is provided may be inappropriately allocated. Historically, we have not had a mechanism to collectively aggregate the need for funding against service outcomes and the wellbeing of communities. The closest we have been able to get is a crude assessment of the condition of the asset base, with an assumption that this relates to the service need of the community. However, we have never been able to define whether measuring the asset base is delivering an equitable level of outcomes to Australians. Nor have we been able to demonstrate whether the level of funding was appropriate to enable the collective outcomes sought by Australian communities.

The evidence collected through state programs [6,7,8 & 9] suggests that the gap in funding is universal. However, in order to develop a well-founded debate at the commonwealth level we need collectively to aggregate the evidence to present a national perspective. Unfortunately, achieving this has been very difficult as there is no universally agreed framework for the definitions and standards used to report this information.

Engaging the Federal Government in a debate about innovative ways to bridge the gap in local resources required to sustain the well-being of local communities will require demonstrable evidence of a consistent national problem. The recent inclusion

of infrastructure in the Council of Australian Governments (COAG) [10] discussions is encouraging. However, unless local government can present a consistent and compelling case the major focus will potentially remain with the big ticket items, despite the fact that community infrastructure accounts for almost half of all government owned assets.

The allocation of Commonwealth funding to the states is based on a measure of road length. However, there are no frameworks or measures in place that can provide assurance that the allocation is providing equitable outcomes [11]. Research by Shepherd [12] suggests that it is those that already have that attract the greater share of the cake. A simple funding model based on needs is also fraught with issues. However, a discussion of this is beyond the scope of this paper.

## 2 THE STRATEGIC OBJECTIVES OF OUR RESEARCH

In order to address these problems we have identified three strategic objectives that we believe will help guide us in taking purposeful action towards improving the situation. The three strategic objectives are:

- communities empowered and equipped to make choices about their future,
- investment decisions driven by agreed community needs,
- local and regional communities able to define and justify the need for assistance.

### 2.1 The Benefit

It is our belief that if these objectives are achieved then they will lead to the following benefits:

- stronger more sustainable communities,
- fairer and more equitable access to state and commonwealth funds.

As a research community one of the most difficult challenges we face is in managing and measuring the realisation of these benefits, which is important to justify the ongoing investment in this work. Evidence that the work is contributing towards stronger more sustainable communities, could be shown by the renewal gap being closed. However, it would be very difficult to demonstrate that such improvements are attributable to this work and not the considerable investment that is also being undertaken in the professional development of Asset Management. The research team is currently investigating methods for measuring evidence that asset investment decisions are being driven from a defined service need to which this work is making a direct contribution [13].

## 3 THE ACTIVITIES OF OUR RESEARCH

If *'communities are to be empowered and equipped to make choices about their future'* then it is necessary that they are engaged in some form of community planning that will define their vision and goals for the short medium and long-term. The concept of using a service oriented framework to drive investment decisions in community assets is underpinned by the assumption that we understand the service outcomes that are required. Without this we may as well continue our investment in assets based upon maintaining what we have.

Fortunately for our research program there are many organisations around the world actively developing and improving the processes of community planning. Our strategy is to build upon this body of work rather than create another methodology. The problem space is not easy and a review of the Victorian Lighthouse projects [14] provides strong field evidence that a 'one size fits all' approach will almost certainly not work. The Victorian experience suggests that empowerment of communities to own their community plans is critical [15]. This goes far beyond the traditional limits of communication and dialogue, as it hands responsibility for creating and owning the community plan to the community. The role of government is an enabler, providing the means by which the process can occur. A more detailed discussion of these concepts will be provided in a subsequent paper where we will discuss the different systems that define and manage the service.

It is our belief that a critical part of the community empowerment process is providing information and knowledge about the existing situation. Note this is more than just data. Communities have to be empowered with knowledge about the outcomes they are seeking to plan for. For this reason we are endeavouring to develop an ontology not a data model. We want to understand the nature of the service outcomes and their relationship to other systems, in particular the relationship between a service outcome and an asset.

If we want to ensure that *'investment decisions are driven by agreed community needs'* then we must provide a framework for:

1. translating community aspirations into service objectives and service delivery and
2. defining the level of asset investment required to enable the required service delivery.

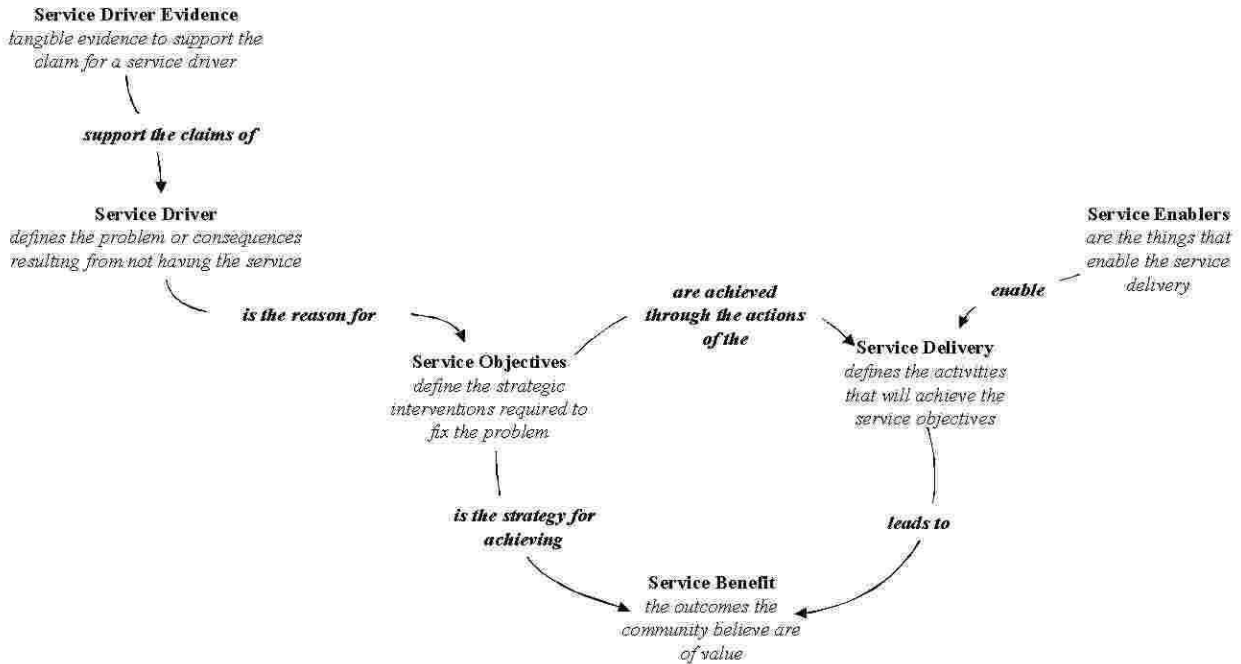
These requirements have a dependency upon both a service and asset ontology being available. The development of an asset ontology is well progressed and for the most part we have chosen to build our frameworks around the International

Infrastructure Management Manual [5] and the Queensland Road Alliance Asset Management Kit [16]. However, the development of a service ontology that relates to the management of assets is much weaker. The majority of well developed service ontology relate to technology based services, which, by necessity, have been developed to support automated web based services. The remainder of this paper present the first in a series of paper where we develop the concepts of a service ontology.

The empowerment of ‘Local and regional communities able to define and justify the need for assistance’ will require the development of a funding allocation framework that can respond to needs in a fair and equitable way. Work in this area is still in its early development and is not reported in this paper.

#### 4 SERVICE ONTOLOGY

Figure 2, shows a map of the key components in the Service Ontology. The key linkage with the Asset Ontology is via the



Service Enablers, which is described in Section 5.

Figure 2. Service Ontology System

##### 4.1 Service Driver

The Service Driver defines the problem that is driving the need for investment in the service. It is usually expressed as a consequence that will occur if the service is not delivered. The framework is better able to drive an investment decision if the consequences of not taking action can be pushed back to the point where they have a tangible impact on the vision and aspirations of the communities for whom the desired service is ultimately aimed.

In defining a service driver it is essential that the team are able to support the claims regarding the problem with factual evidence: anecdotal evidence or hearsay is considered insufficient to support an investment in a service. This is where the role of Local Government and the frameworks we are developing, as enablers of community planning are of vital importance. The ability to measure service outcomes, asset conditions and performance etc, is essential in assisting communities rationally justify their decisions based on informed knowledge of the situation.

##### 4.2 Service Objective

The Service Objectives are the strategic interventions required to fix the problem situation. They define at a high level the service outcomes that must be achieved if the problem situation is to be transformed to deliver the specified benefits to the

community. We propose the Service Objective should be defined as part of the Service Strategy and are the responsibility of the Corporate Executive team.

### 4.3 Service Benefit

The Service Benefits describe the value the community derives from the achievement of the Service Objectives. The Service Benefits generally correlate closely with the broad strategic goals that communities and governments identify as their priorities for the future. For example, in Victoria the state government has published Growing Victoria Together a set of 10 outcomes that guide all of its investment decisions [17].

### 4.4 Service Delivery

Service Delivery defines the activity or activities that must be undertaken in order to achieve the Service Objectives. It is the execution of the Service Delivery that leads to the benefits being realised by the community.

The concept of Service Delivery is recursive, that is, a service may be delivered by one or more services. A service can be an assembly of services that when combined deliver the Service Objective. The Service Delivery is generally defined as part of the Service Plan and is largely the responsibility of operational managers.

### 4.5 Service Attributes

We define four core service attributes that are evident at both the level of Service Objective and Service Delivery.

#### 4.5.1 Service Demand

Service Demand is a measure of the level of usage by the community of the service. Demand is seldom uniform, for example, the services associated with a sporting facility may experience almost all of their weekly demand between 8:30 am – 2:00pm at the weekends, similar to the demand profile shown in Figure 3. Therefore, when measuring demand it is necessary to consider the demand profile. A service provided to the community may have very high peak loads that last for narrow windows of time. If these services are supported by a significant investment in assets, then for large periods of time that investment is largely unproductive. The challenge facing many communities is how to increase the overall benefit received from a range of assets that were originally built with a very narrow range of specific services they supported.

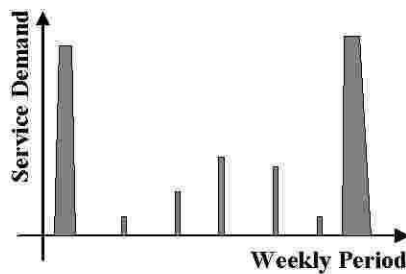


Figure 3. Example of Service Demand Profile

In determining future investment decisions it is necessary to understand the changes that are occurring in the demand for a service. Therefore, where possible decision makers need to know past usage levels and forecast demand. However, in order to compensate for changing demographic trends it is recommended that per capita measures are adopted, where the per capita count is measured against the relevant population cohort. For example, in a community that has an expanding aging population, but has a declining child population, any assessment of preschool facilities forecast demand needs to be based on the appropriate population cohorts of preschool children and potentially child bearing adults.

#### 4.5.2 Service Capacity

Service Capacity is a measure of the “load” the service can ultimately carry; for example, the number of pre-school places that can be provided by the current service configuration.

#### 4.5.3 Service Utilisation

Service Utilisation is a derived measure that expresses the percentage utilisation of a service. It is simply the ratio of:

$$= \frac{\text{Service Utilisation}}{\text{Service Capacity}} \quad (1)$$

#### 4.5.4 Service Performance Measures

Service Performance Measures are the recorded, usually observed, measurements that are used to monitor the Service Delivery against a specific service Key Performance Indicator as shown in Figure 4.

### 4.6 Benefits and Performance Measurement

The service ontology has two primary measures, the first we define as the Critical Success Factor (CSF) that defines how a provider, such as local government, will determine if the service is a success in delivering the benefits to the community. The primary focus of the CSF is to communicate with the community how their investment in the service is performing against the benefits that it was forecast to achieve. The second set of measures are what we have described as Key Performance Indicators and their primary function is for the organisation to monitor and measure how effectively the service is being delivered against the stated objectives. Typically the Service KPI will be more technical and detailed than the CSF. The KPI must relate the Service Objectives to the Service Delivery and also tie into the CSFs. A combination of KPIs may be used to report the CSF.

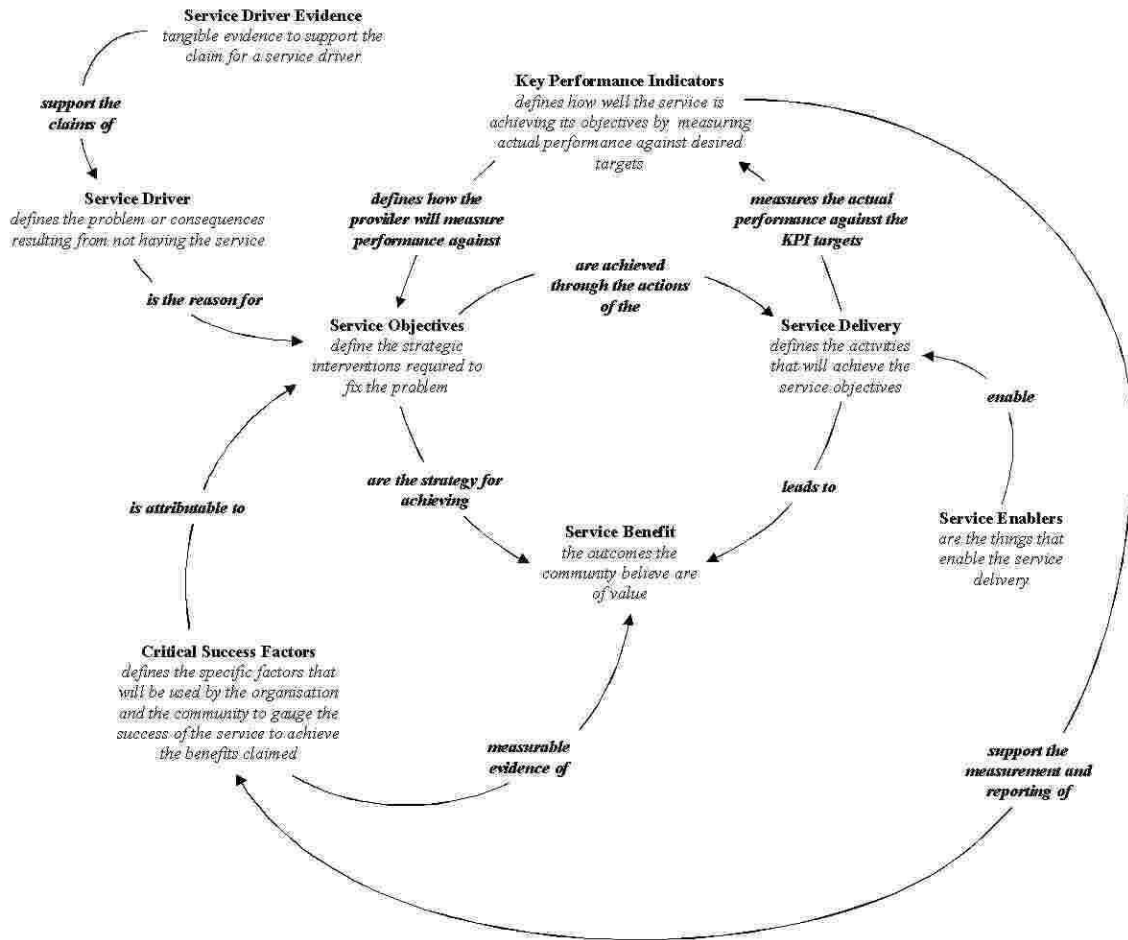


Figure 4. Service Measurement

#### 4.6.1 Critical Success Factors

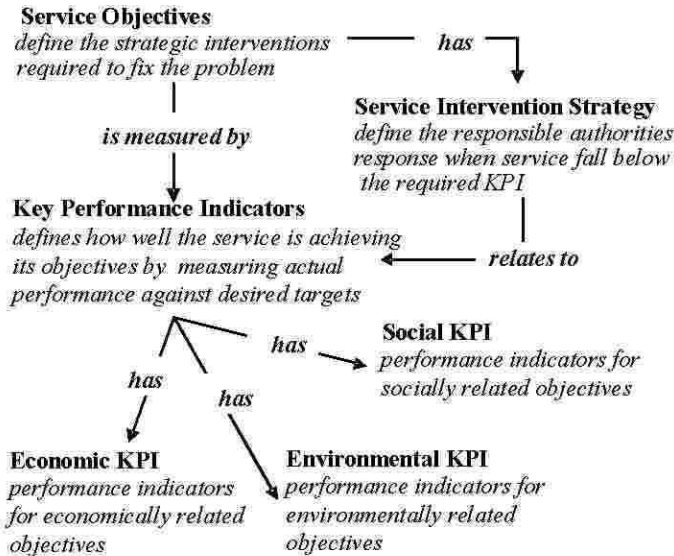
Critical Success Factors (CSF) are the instruments by which the service provider is held accountable to the beneficiary (usually the community) for the service outcomes. The CSFs inform the community whether or not the service has been a success, they link the contributions made to the benefit with the achievement of Service Objectives. The CSF must be both measurable and primarily attributable to the Service Objectives.

It is recommended that each benefit has two CSFs. Defining appropriate CSFs is a challenge as they need to be both measurable and attributable; providing a linkage between the Service Objective and the benefit obtained.

The CSFs also have an additional role in helping resolve potential conflicting interest between KPIs. For example, a service strategy may identify KPIs relating to both safety and travel time as important. However, both may not be achievable within the investment budget. The CSFs provide a mechanism for determining which KPI takes precedence in driving the Service Enabler requirements.

#### 4.6.2 Key Performance Indicators

Each Service Objective has an associated set of Key Performance Indicators (KPIs); these measure how the service providers, such as councils, are performing in respect of the Service Objectives. The primary use of the KPIs is for corporate governance of the service. However, in some circumstances KPIs may be applied to the reporting of CSF, either as a raw measure or combined. Most KPIs will have a target performance level that defines the provider’s target or minimum obligations in delivering the service. Typically, KPIs are divided into three sub-sets that equate to a conventional Triple Bottom Line (TBL)



business assessment [18], namely; social KPIs, environmental KPIs and economic KPIs. The social KPIs define service performance outcomes relating to requirements such as safety and health. The environmental KPIs define service performance outcomes relating to requirements such as noise and pollution. The relative importance of the environmental KPIs is rapidly gaining momentum as communities increasingly expect local government to take a lead in environmentally responsible and sustainable development within their community, for example, many councils in Victoria actively measure their GHG emissions and carbon footprints [19]. The challenge for most councils is that the downstream applications, where it would be most effective to measure these outcomes, are currently lacking the capability. Economic KPIs, relate to both the immediate financial costs associated with the service and the indirect financial consequences to the community, such as increased transportation costs.

Figure 5. Service Objectives Semantics

Associated with each Key Performance Indicator is an intervention strategy that defines strategically how the organisation responsible for delivering the service will respond when service performance levels fall below the KPIs. A semantic schematic showing the relations between the KPIs and Service Objectives is shown in Figure 5.

#### 4.7 Service Enablers

Service Enablers are those things that are required to support or enable the service to be delivered. Service Enablers may be either asset or non asset based, (assuming a conventional view that assets are tangible, inanimate objects). It is the Service Enabler that provides the critical link with assets. The Service Enabler is the link between the Service Ontology and the Asset Ontology.

### 5 ASSET ONTOLOGY

The nature and relations of assets is well documented and we do not proposed to develop an in-depth treatment for an asset ontology in this paper. The following is a high-level summary for the purpose of demonstrating the linkages between the two ontologies. We propose that assets have the following attributes, as shown in Figure 6. The measures used to quantify demand, performance, capacity and utilisation will in most instances carry through to the Service Delivery attributes. However it cannot be automatically assumed that the quantification and measurement of an asset will translate directly to a service, as a service may utilise several different assets in achieving the service outcome.

Our objective in developing the framework is to create a clear ‘separation of concern’ between the service and asset ontologies. In order to help differentiate between the Service and Asset we have deliberately removed the term service from the



attributes of an asset, we believe the common use of the term ‘service level’ as an attribute of the asset is confusing as it is frequently interpreted as the Service Delivery KPI.

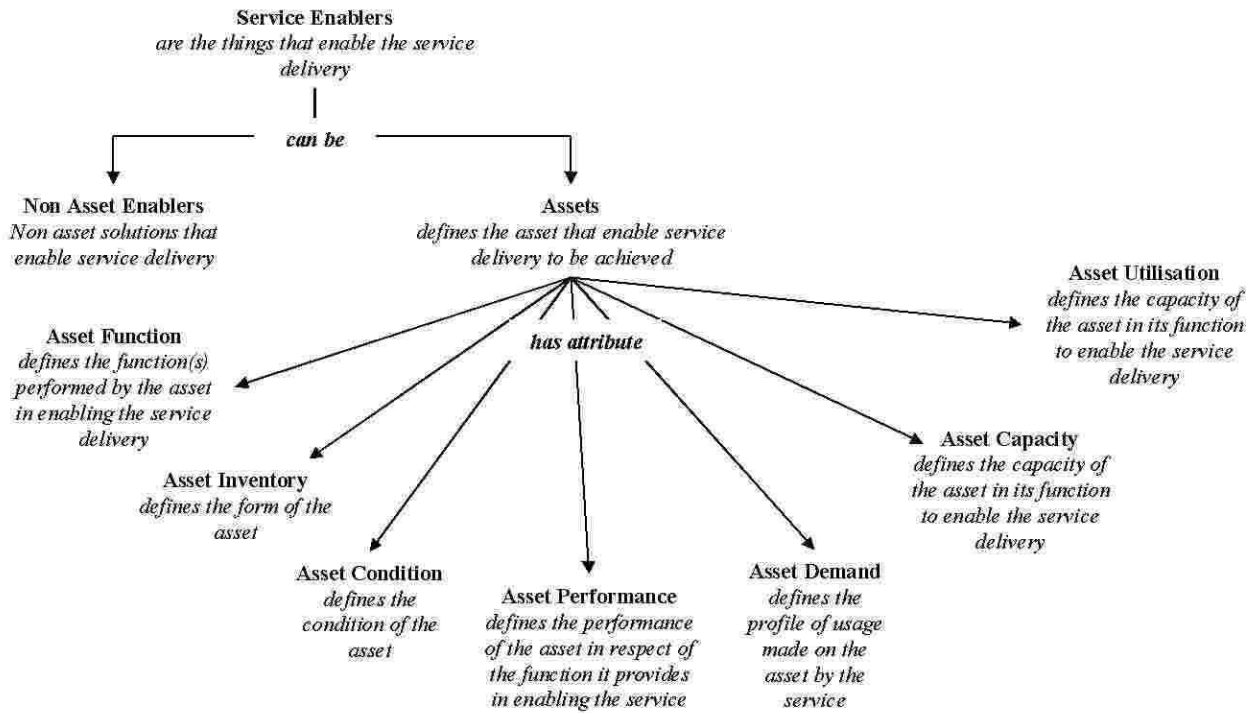
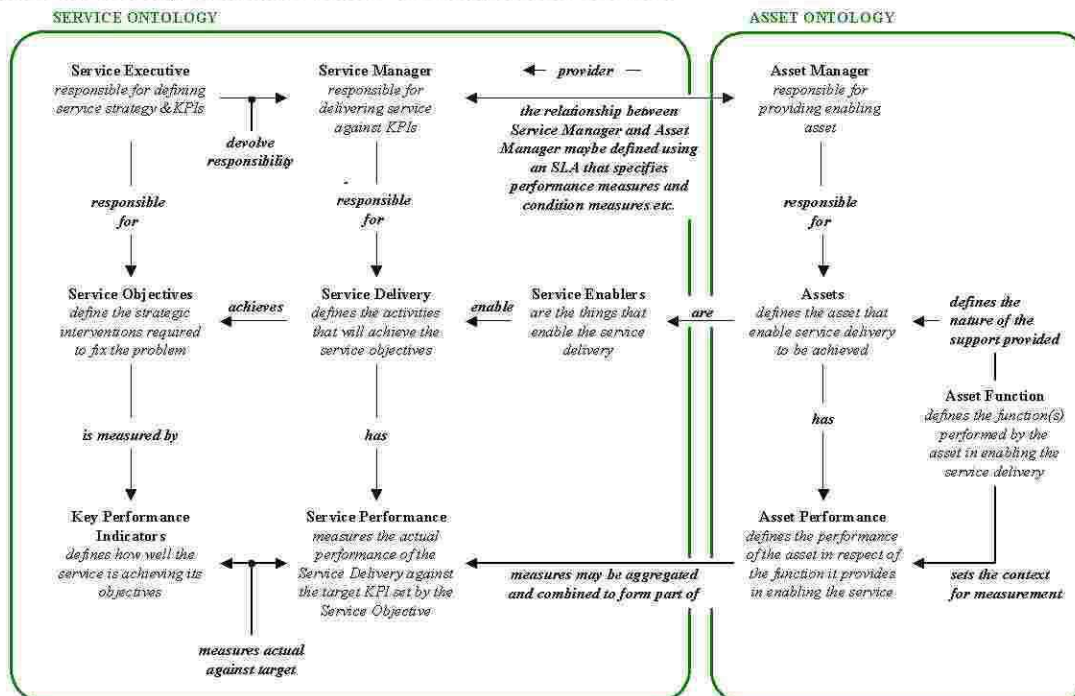


Figure 6. Asset Attributes

Our conjecture is that an asset enables a service. The service has an agreed standard; the target service level is set by the Key Performance Indicator, the actual service level is measured by the Service Delivery - Service Performance. Attainment of the service standard is enabled by the asset functioning at an agreed performance level. We assert that an asset performs a function, not a service, in respect of enabling a service to be delivered. We do not assign a service level attribute to the asset; rather we define the relationship between the service that is enabled and the asset.



### Figure 7. Relationship between Service Ontology and Asset Ontology

The performance of the asset in respect of the service that is enabled is measured by a performance measure, not a service level. A schematic of the semantic relationships is shown in Figure 7.

The relationship between the Service Manager and the Asset Manager maybe defined by a Service Level Agreement (SLA). A more detailed treatment of this relationship will be presented in subsequent papers where we will explore the instruments commonly used to manage the framework.

## 6 CONCLUSIONS

We have presented the start of a service oriented framework to support sustainable investment in community assets and infrastructure. This paper establishes the need for such a framework, proposing that it should be driven by a desire to build stronger more sustainable communities. This framework will help focus the debate regarding the renewal gap that exists between the requirements to maintain, and modernise our infrastructure and the funds available to do so. It will shift discussions from a focus on the asset to a focus on community outcomes. We have demonstrated that if we are to make improvements to the current situation then we must empower communities to make choices so that investment decision can be driven from agreed community needs.

To achieve this we have shown that there is a requirement for a service ontology that will enable the development of a framework to support investment decision in assets being driven by service outcomes. In this paper we have presented a service ontology defining the nature of a service and its performance, in particular how it is measured. The service ontology has a defined linkage with the existing asset ontology via the concept of service enablement. Many of the measures that are currently used to assess the performance of an asset may also carry through to the service ontology and we have shown how these relations may function.

The next stage in the development of the methodology is to show how these components are assembled to provide a framework for managing community infrastructure. We will follow this with case studies showing how the framework is used by local government.

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