GIS FOR MANAGING TELECOM NETWORKS
WHITE PAPER

GIS for managing telecom networks

The foundation of effective network design, build, operations, and extension

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Introduction:
A GIS and network management primer

What is GIS?

Let's start by defining and understanding GIS. What is it?

Essentially, it's a system that creates, manages, analyzes, and maps any kind of data. It connects this data to a map and integrates data related to location (which tells you only where things are) with additional descriptive information, such as conditions at that location.

For the telecoms operator (or any other enterprise), the result is a comprehensive foundation for mapping and analysis. GIS makes it easier to understand patterns, relationships, and geographic context. It contributes to delivering better communication and efficiency, improved management and decision making.

In broad terms, GIS can be used to:

- Pinpoint the location of physical assets
- Make decisions regarding where to plan future networks
- Identify problems
- Monitor change
- Manage and respond to events
- Improve forecasting
- Set priorities
- Understand trends

The competitive landscape in telecoms

Unrelated directly to GIS but, as we'll see, highly relevant to the topic, let's also understand (at least at a high level) the present-day landscape facing telecommunications operators. Understanding this landscape will help us to see why location information is so important.

Operators have to manage complex and, often, new technology. They must do so at the same time as running a competitive business and scaling to meet market demands without compromising profitability.

Success brings both growing volumes of traffic to manage and growing expectations from customers that must be met. And today's customers have high expectations. Both operational stability and sustained performance are critical to success.

Ensuring operational stability and sustained performance

These demands put pressure on the systems involved in managing and maintaining the network. Can they cope as the business expands? Can they do so while providing the stability required? And, as more functional capabilities are needed to support service innovation, is the technology capable of seamlessly delivering additional performance when needed?

Having access to this agility and adaptability is a critical component of success and the cost of failure is high. A lack of responsiveness to customer requirements and service innovations can undermine commercial growth. And as we will see, in many of the key functional areas of the telco business, location information plays a critical role.

Brief examples of this include:

- The importance of knowing where, geographically, network assets are situated
- Eliminating geographical redundancy in network planning
- Siting network expansion where new demand is present
- Planning new rollouts optimally and in relation to other assets that will support new investments
- Optimizing network performance, whether Fiber, FTTH, microwave, mobile, or other
- Impact and point-of-failure analysis

...it's not just location information but also the context GIS provides that's important. This is because location data needs to be intelligent; not just a geographical point on a map but enhanced by understanding of context: the presence of properties, other utilities, government information, and more.

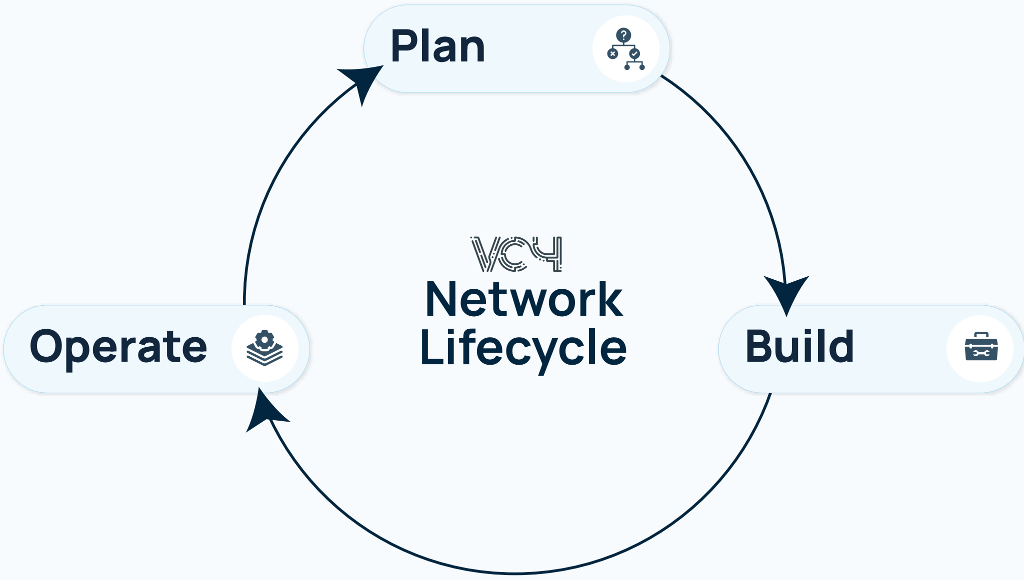

Figure 1: Plan, build and operate - the complete network lifecycle

The importance of **location information** in the network lifecycle

At a basic level, there are three key phases in the network lifecycle: planning, building, and managing. This is also sometimes known as DIO (design, implement, operate), or PBO (plan, build, operate). This process is followed whenever new requirements need to be met by the operator.

Location information is fundamental at all three phases.

Further, as we noted in the first section, it's not just location information but also the context GIS provides that's important. This is because location data needs to be intelligent; not just a geographical point on a map but enhanced by understanding of context: the presence of properties, other utilities, government information, and more needs to be accessible.

This additional information comes in three types: spatial, attribute, and metadata. Examples include vector data, raster or grid data, and imagery of remote sensing data.

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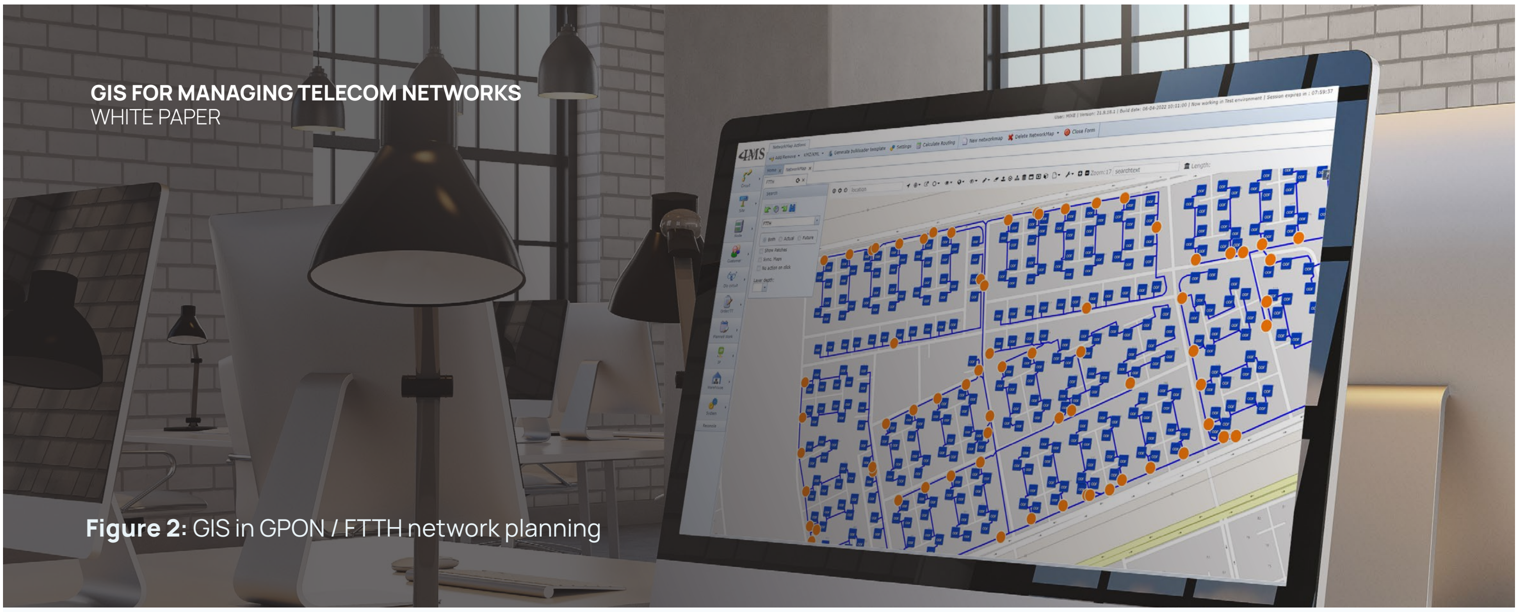

Figure 2: GIS in GPON / FTTH network planning

You can't build a network without knowing what features are in the landscape

It doesn't take a leap of faith to grasp how critical this information is for the telco operating a network. For instance, if fiber rollout projects are under consideration, knowledge of local obstacles is a key aspect of planning:

- Are new development works planned in the area?
- Where are existing cables, sewers, pipes, and other utilities located?
- Where is existing infrastructure, to which the new deployments will be connected?

Without an understanding of the components that impact physical delivery of the fiber, it's impossible to know if the premises being targeted can even be reached.

Example: GPON design relies on location information

GPON (Gigabit Passive Optical Network) technology gives us an example of this reality.

GPON is a cost-effective, popular option for network operators seeking to bring Fiber to the Home (FTTH). It covers the "last mile" with a single strand that delivers high Internet speeds to multiple end users. As a result, the GPON approach has obvious appeal but making the technology work in practice is challenging.

While legacy networks are founded on point2point principles, GPON's approach is point2multi-point, meaning passive splitters are required to direct traffic.

Where a cable must be split to connect multiple properties, GIS information is critical to network planning - exposing knowledge of the correct fibers, relevant properties and, in turn, identifying splicing requirements that need to be considered. Location is central to both designing and activating a service and, thereafter, to managing capacity, troubleshooting and more.

The role of GIS in planning such networks can be seen in Figure 2.

If you're laying cables by digging trenches (or, for that matter, using aerial pathways), you need to understand the relationship between your assets (proposed or existing) and others that may also exist - for instance, utility cabling, water pipes and so on - in order to plan. Any network build will invariably run up against existing infrastructure obstacles.

The importance of **GIS in network planning**

As we've seen, location isn't simply about physical coordinates but context. Further network planning examples underline this.

Trench build

If you're laying cables by digging trenches (or, for that matter, using aerial pathways), you need to understand the relationship between your assets (proposed or existing) and others that may also exist - for instance, utility cabling, water pipes and so on - in order to plan. Any network build will invariably run up against existing infrastructure obstacles - making access to an accurate map which is continuously updated, vital to successful completion of the project. The same holds true for locating poles.

Wayleaves

Wayleaves are contractual agreements between landowners/landlords and telecoms providers that grant access rights to enable the operator to install, maintain or repair equipment. There may be multiple providers authorized to use a wayleave. Wayleave information is a critical component of GIS because this is vital to ensuring that permitted routes are not only followed but also without impacting other users of the same access rights.

Street view

A myriad of detail needs to be considered in planning, even at microscopic level. Cables, ducts, manholes, handholes - all have to not only be identified but identified by exact location. You cannot, for instance, optimally plan a new FTTH deployment in a locality without this knowledge. If you tried, it would likely increase the cost per connection and thus escalate costs for the complete rollout as you run into unforeseen problems. Such problems can be avoided with accurate GIS data at the start. Thus, GIS can be seen as a necessary component of FTTH design. This is particularly important where projects are publicly funded, and meeting budget requirements is a priority.

Advance knowledge of where any impacts will occur can enable proactive communications. Where, for example, there is a Single Point of Failure in the network, GIS can identify the location and which back-up systems might be available to immediately remedy the problem in the short term, while a more permanent fix is deployed. Examples of this might include adding satellites for contingency planning or building out new routes that bypass and eliminate potential Single Point of Failure (SPOF) locations.

There are numerous other examples. For instance:

- Mobile extensions, where new cell sites require fiber connectivity
- PON deployments extended to buildings
- Multi-dwelling properties/houses of multiple occupation
- Railway infrastructure where fiber is required for signaling purposes
- Compound buildings, where utilities are centralized

Networks are not isolated: the landscape is dynamic

Additionally, it should be underlined that availability to access knowledge of other utilities – gas, geothermic, cooling, electricity – that coexist with telecoms networks is also a critical feature of GIS.

This information must be integrated to create a dynamic picture of the network in its broader physical context, a picture that grows with the asset base and provides a clear view, ideally with color coding to distinguish between planned connections, those in service and those about to change status.

Moreover, this should include a standard naming convention for example, based on the ITU-T's M.1400 recommendations, ensuring consistency for all assets.

With mapping, operators have a quick and easy way to manage and resolve reported issues – and impact analysis enables them to keep customers informed about problems, because they can understand who else might be affected.

The impact of GIS on the **end-customer**

The value of GIS extends beyond network planning and build,it goes all the way to the end customer's experience. In fact, GIS is increasingly important to end customer service. As networks evolve, customer needs must precisely align - not just to ensure delivery excellence but also so operators can easily expand their networks and include new systems to meet customer demands when it's necessary.

Location thus plays a central role in customer care. The obvious example is that for any customer-reported issue, information like the location of the issue, type of issue, and volume of related reports are central.

Where a problem occurs, are there other outages in the same geography? Can affected customers be continuously updated on progress to resolve the problem? Are staff sent regular, automatic progress reports? Critical information will all be sourced from a GIS-capable information system, augmented with the additional contextual information required.

Mapping functionality can keep customers satisfied

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Advance knowledge of where any impacts will occur can enable proactive communications. Where, for example, there is a Single Point of Failure in the network, GIS can identify the location and which back-up systems might be available to immediately remedy the problem in the short term, while a more permanent fix is delivered. Examples of this might include adding satellites for contingency planning or building out new routes that bypass and eliminate potential Single Point of Failure (SPOF) locations.

The leading analyst firm, McKinsey, concluded that to achieve success, telcos will require a new mindset and a re-imagining of their businesses[1]. One of the critical areas identified is the approach to customer engagement. As digital natives set a new benchmark for customer experience, operators must rethink their approach to serving, satisfying, and delighting customers. GIS is likely to play a significant role in this future.

Another example of the value of GIS data is in checking faults using OTDR. This requires the ability to pinpoint exactly where in the ground a fault lies. Here, knowing location and distance is only part of the story. Knowing whether you can excavate and fix at the lowest cost is equally important. You can identify the fault, but can you reach it? GIS information tells you the answer.

1. https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/a-blueprint-for-telecoms-critical-reinvention

The importance of **GIS in network management**

We've established that GIS information is critical in the planning, design, and service delivery of the network as well as in delivering high quality customer experience. What about the actual management of the network? In service, operators must consider whether their assets are used or not, which may need building out, and which others might no longer be required. This brings location into the domain of network management.

Here GIS information is vital. It allows operators to understand where these assets are located so that, when necessary, they can be eliminated. In practice, this can lead to savings of millions of dollars. For example, an operator might be billed for services from leased line providers – but what if these have been made redundant due to routing changes?

Unless the invoices can be correlated with accurate GIS data of the connection in question and this information can be enriched with real data regarding traffic flows and capacity over this link, the operator cannot reliably validate the accuracy of the bills. Put simply, understanding the status of links and where they are, so discrepancies can be identified, is a fundamental requirement. This is applicable to all networks – for example, WDM, as illustrated in Figure 3.

It's impossible to avoid the conclusion that today, automatic discovery and reconciliation of network performance is essential for assuring the continuity and performance of network-borne services. Having an accurate, up-to-date view of constantly changing assets, both logical and physical including GIS location information, is a fundamental requirement...

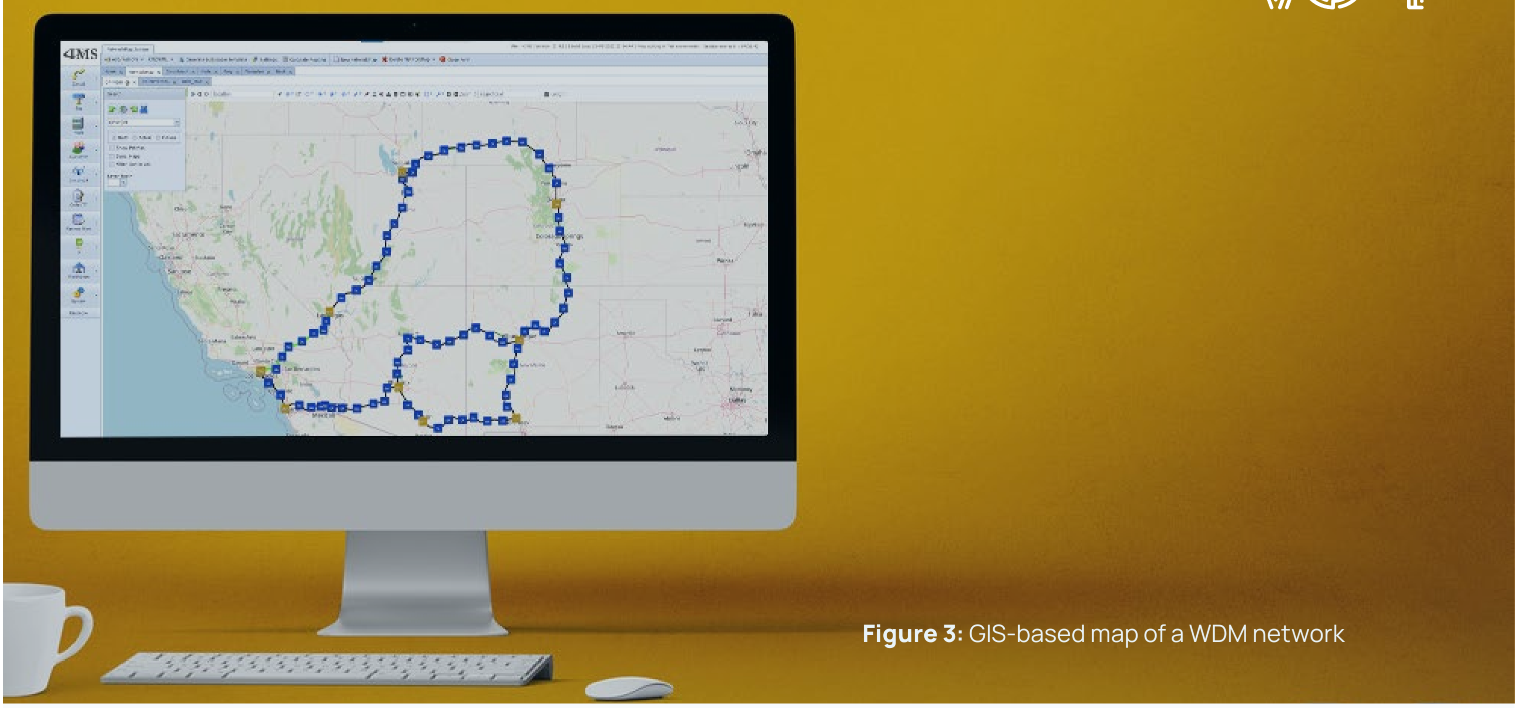

Figure 3: GIS-based map of a WDM network

What's the use of identifying a problem if you don't know where it is?

Another example of the value of GIS data is in checking faults using OTDR. This requires the ability to pinpoint exactly where in the ground a fault lies. Here, knowing location and distance is only part of the story. Knowing whether you can excavate and fix at the lowest cost is equally important. You can identify the fault, but can you reach it? GIS information gives you the answer.

This suggests that GIS information must also be integrated into field tools (tablets/ mobile devices) as well as central applications to empower technical teams to act quickly. For instance, by checking network links on the ground rather than having to rely on information fed back by those in the office. Of course, if you don't know where things are, you can't fix problems efficiently, let alone deliver network services at best cost.

GIS data, accurately integrated with other contextual information has the potential to deliver performance improvements, by driving operational efficiency and service delivery effectiveness. And, in an era likely to be hallmarked by the delivery of new services and innovative solutions, but with unprecedented demand for enhanced customer experience, GIS is likely to play an even more central role.

It's impossible to avoid the conclusion that today, automatic discovery and reconciliation of network performance is essential for assuring the continuity and performance of network-borne services. Having an accurate, up-to-date view of constantly changing assets, both logical and physical, including GIS location information, is a fundamental requirement for avoiding service disruption, long delivery times, high costs and inefficient planning.

In the telecommunications industry, processing (GIS) information is the domain of the Network Inventory Management platform. One leading example is VC4-IMS. It collects raw data from data from multiple endpoints in the network, normalizes, and then reconciles it – including GIS data from relevant and reliable sources.

Summary

Both network planners and service providers face a challenge. Comprehensive knowledge of each network asset is critical for success in both network planning and service delivery.

The information required, for which location and context are central, is the foundation on which both operations and customer experience can be improved. Network planning and Network Inventory Management are critical to bringing clarity to assets and providing operators with a foundation for ensuring that their investments in agile network evolution deliver the performance and results.

GIS and Network Inventory Management from VC4

In the telecommunications industry, processing this information is the domain of the Network Inventory Management platform. One leading example is VC4-IMS. It collects raw data from multiple endpoints in the network, normalizes, and then reconciles it – including GIS data from relevant and reliable sources.

As a result, VC4-IMS delivers a critical, panoramic view of all physical and logical resources in the network, giving the operator a clear, unified understanding of live network assets, their location, their utilization and their configuration at any given time. The platform can also be integrated into the network itself to perform auto-provisioning (service fulfilment) which facilitates building and rolling out services in the network.

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