GE Energy

Digital Energy

How Smallworld™ Supports Next Generation Access Networks

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imagination at work

1 What is a Next Generation Access Network?

The European Commission defines a Next Generation Access (NGA) Network as "wired access networks which consist wholly, or in part, of optical elements and are capable of delivering broadband access services with enhanced characteristics (such as higher throughput) as compared to those provided over existing copper networks. In most cases, NGAs are the result of an upgrade of an existing copper or co-axial access network"[1] .

Generally, NGA includes fiber-rich infrastructure and technologies such as fiber-to-the-cabinet (FTTC), fiber-to-the node (FTTN), fiber-to-the-building (FTTB), fiber-to-the-home or premises (FTTH/FTTP) and upgraded cable TV networks. Figure 1 shows the different types of FTTx. Fixed wireless and mobile technologies such as Wi-Fi, WiMAX and LTE are alternatives to NGA for providing internet access.

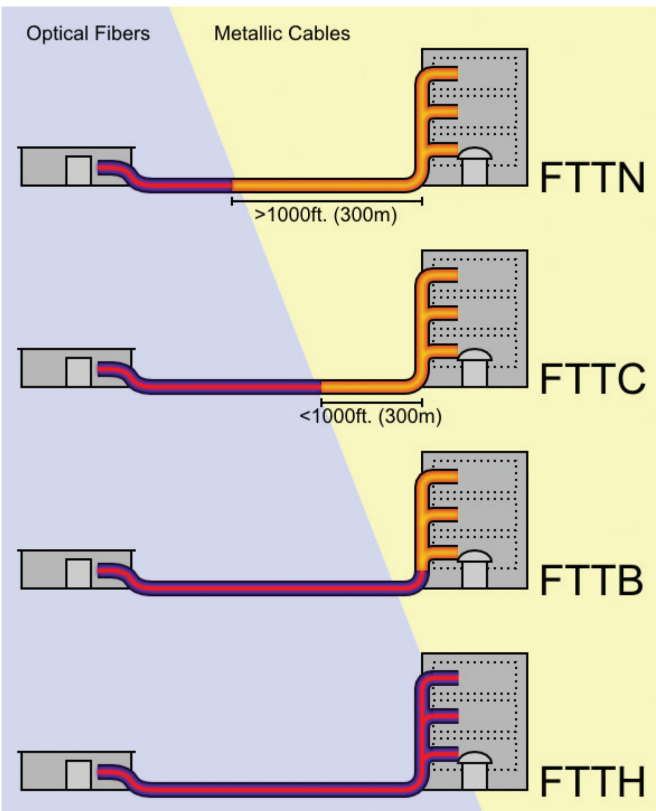


Figure 1: Different types of FTTx

Transforming telecommunications networks to NGA means overcoming the challenge to deliver high quality broadband services. The provision of higher levels of broadband access is driven by both commercial pressures and governmental initiatives, conscious of research showing that GDP can increase by 1% annually for every 10% increase in broadband penetration[2]. For instance, the European Council's Digital Agenda for Europe (DAE) targets are ambitious, including 100% internet coverage by 2013; 100% coverage at speeds of at least 30 Mbit/s by 2020; and 50% household take-up of at least 100Mbit/s by 2020[3]. And in the US, the government's Broadband Stimulus program is encouraging more players (including local authorities) to become involved in ultra-fast broadband rollout.

This growth represents a major challenge on the network supply side, with a need to provide extensive availability of ultra-fast bandwidth over the next few years. One implication of the drive toward faster broadband is a decline in basic broadband penetration, and the transition of customers to faster services. There are several commercial, operational and regulatory issues involved in such a migration, including the likely switch from a copper-based network to a fiber-optic one, which introduces a major challenge for network operators to meet the fast broadband target.

Currently there are around 67 million[4] FTTH\B subscribers worldwide. And with many countries supporting ambitious government initiatives by rolling out FTTH networks at faster rates, this is predicted to rise to 142 million FTTH users by 2016[5]. As such, there is a critical requirement to support quick, cost-effective design and build of FTTx (home, building, cabinet) networks in the next 5-10 years. Such aggressive deployments will require significant investment, and service providers will need to ensure their processes are as efficient as possible to support this scale of rollout.

2 Deploying NGA successfully

Whether the NGA network is deployed by a new entrant or an incumbent operator with an existing legacy network, the same plan, design, build, operate and maintain processes must be efficiently executed to achieve a successful NGA network deployment. Underpinning many aspects of these processes is a network inventory. Due to the inherently geospatial nature of an access network, a geospatial network inventory system is required. Using this type of system can lead to a rapid return on investment. GE's Smallworld Network inventory solution is used by more than 120 service providers around the world. In many cases, they use GE's solution to support NGA deployments. Following are some of the benefits operators using the Smallworld solution experience:

- Reduced capital expenditures on network infrastructure through more efficient designs of Passive Optical Networks (PONs) and point-to-point fiber networks, improving usage of network resources
- Reduced operational expenditures through the use of automated tools to plan and design FTTH networks, increasing workforce productivity
- Faster return on investment for new network by reducing time spent in network design, accelerating time to market for the new services
- Faster provisioning through accurate qualification of the physical path to support a service request and the assignment of the network resources to that request
- Reduced network downtime due to rapid and accurate location of faults in response to network alarms on the FTTH network
- Reduced repair time due to rapid location of fiber breaks and faulty equipment
- Significantly improved customer satisfaction, resulting from rapid rollout of FTTH network, as well as accelerated time to market for new broadband services and improved quality of service

To realize these benefits, GE's Smallworld solutions must provide support to a wide range of processes that contribute to the overall plan, design, build, operate and maintain lifecycle, as shown in Figure 2.

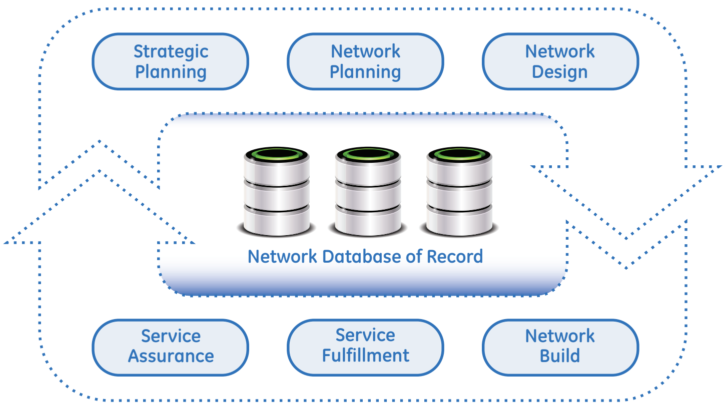


Figure 2: The plan, design, build, operate and maintain lifecycle

The following sections describe how Smallworld's portfolio of products provides specific support for each phase of this life-cycle.

2.1 Network database of record

A consolidated network inventory forms the heart of the Operational Support Systems (OSS) by providing a central database of record for the network infrastructure, both physical and logical, enabling a complete view of all network resources. It contains critical information used to support many key business processes within the OSS.

Building upon the industry-leading Smallworld Core geospatial platform, the Physical Network Inventory application provides a complete, end-to-end view of the physical network, supporting multiple communications technologies and equipment from multiple vendors. The network is modeled from the customer's premises through the distribution network and into the core transport network. Inside and outside plant data are combined to represent the entire system from ports on rack-mounted equipment to the external fiber network. To manage the logical network, the Smallworld Logical Network Inventory can be layered on top of Physical Network Inventory, or integration can be achieved with a third party logical inventory system, if necessary.

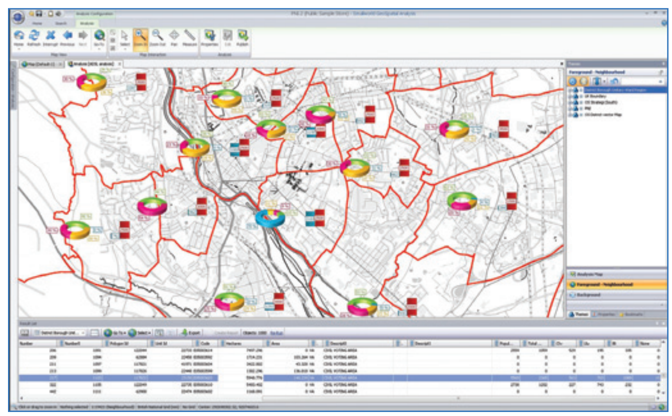
Recognizing the critical role network inventory data plays in running a network operator's business, a primary direction of the Smallworld Network Inventory portfolio is to provide open, standards-based access to the data and to support integrations with best-in-class systems within the OSS. This integration is facilitated through the use of open APIs, support for industry standards and a powerful plug-in architecture. Examples of the types of integration global customer sites around the world have undertaken include interfaces with SAP® (for network plan and build), IBM® Tivoli Netcool (for service assurance), Oracle® Siebel (for service qualification) and Amdocs Cramer & Oracle Metasolv (for service fulfillment).

2.2 Strategic planning

As shown in Figure 2, the first step in any new deployment is to consider the wider business objectives and strategy as part of a strategic planning process. Strategic planning is usually performed by a different set of users to those performing the detailed network design. These users need to combine data (both spatial and non-spatial) from a variety of sources and visualize it in one environment. Users will use customer and market demographics, network infrastructure footprints, service areas and finance data to create possible strategies for proposed network investment plans. These plans will drive network upgrades and new build construction programs as well as provide high level timing and priorities.

Smallworld GeoSpatial Analysis provides an easy to use Microsoft® Office-style application and provides users with visualization, query, analysis and reporting capabilities. These capabilities allow users to combine different data to generate new insights from source data. Smallworld GeoSpatial Analysis introduces the concept of business objects, which link together spatial and non-spatial information, maps, photographs, documents and websites in a unique and flexible way. These business objects match end-user needs and form the basis for detailed analysis and further visualizations. The data remains in its source format and original location so GeoSpatial Analysis does not require expensive, time-consuming data extraction or distribution, maintaining data integrity and simplifying deployment significantly.

Users can use GeoSpatial Analysis to identify high value areas to target with new network build. An example is depicted in the following screenshot which shows demographic data by geographic area.



GeoSpatial Broadband Analysis

2.3 Network planning

Once strategic planning has identified the high value areas to target for a new network rollout, it is necessary to drill into the next level of detail to determine precisely what type of network will be deployed. The planning phase has traditionally been done with desktop tools such as street maps, sketches and spreadsheets, producing highly inaccurate material quantities and cost estimates. Detailed design of the underground infrastructure and cable network that is not based on accurate real-world models and standards-based rules and templates means a lot of rework in the field, material discrepancies, cost overruns and delays. GE's experience tells us the right system approach can help avoid these costly pitfalls. Planning of proposed network infrastructure should be based on underlying data that includes imagery that shows the conditions, addresses that indicate customer demand, lot parcels for service drop locations and current infrastructure availability.

In the case of FTTH, there are several possible options for deploying an NGA network, such as determining whether the service provider should deploy a Passive Optic Network or a point-to-point network. These decisions may have already been answered, and the service provider just needs to generate a cost estimate for building a particular technology in the area(s) identified by strategic planning.

Further within these high level options, there are a large number of modifiable parameters that will affect the overall cost of the network build. To determine the optimum value for these parameters, service providers can utilize specialized mathematical optimization software. This software is very much a black-box engine with no user interface; however, the input for these solutions is the same: the fiber demand, the location of the demand and the network, and the input parameters for the calculations.

The Geospatial Network Inventory is the source for the network data and location-based information, which is fundamental to these calculations. Therefore, GE provides an interface to these calculation engines from within the Physical Network Inventory environment. The result of such analysis is a proposed plan for cable and equipment layouts including costings. This plan can be modified and subsequent iterations performed to arrive at the optimal solution for the given constraints.

Reaching this stage of the process can be achieved quickly using existing data within the organization. There is likely to be a period of time that passes before the next stage continues. During this time, the service provider will assess the business case and decide if they will go forward with this deployment, given the expected return on investment. However, when the service provider is ready to proceed, the output from the network planning stage can be used as the basis for the detailed engineering design that is now required, as described in the next section.

2.4 Network design

In this phase, the detailed design for the new network build is performed. The rollout plan for the new technology will have been determined as part of the high level network planning phase. Now each of the targeted areas can be assigned to network designers, and based upon the output from the network planning stage, they can design the detailed network to support the rollout.

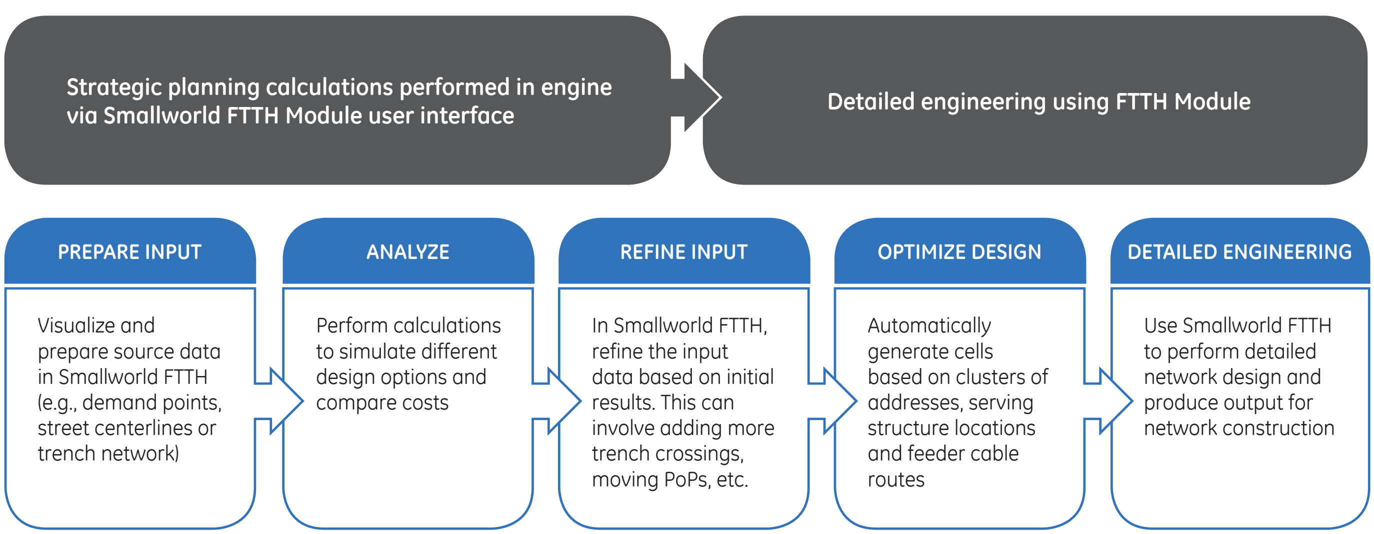
Prior to the detailed design phase, it may be necessary for the designer to undertake a field visit to double check possible locations for cabinets, manholes, etc. and to check the state of any existing infrastructure in an area. GE's Mapframe™ FieldSmart solution provides a number of functional modules that are ideally suited to support the end user in these types of walk-out surveys. The FieldSmart solution runs on tablet-based hardware and does not require a live connection back to the database, so it is suitable for use in all areas or inside manholes if necessary. The surveyor can mark up the identified changes or make comments and reminders, attach photos to locations, and utilize on-board GPS capabilities for accurate positioning. All this data is then seamlessly available within the Physical Network Inventory desktop application in the office and used to support the detailed design.

For FTTH networks, GE provides an extension to Physical Network Inventory which provides an automated solution (Smallworld FTTH) for FTTH design. This module takes the key outputs from the planning phase and then guides the user through a series of steps to arrive at a complete network design for a specific group of customer locations.

The Smallworld FTTH solution supports all network deployment types with the primary focus of the solution on the design of Passive Optic Networks or point-to-point networks deployed via blown-fiber technology or direct buried cables.

The system presents the automated elements of the workflow to the end user in a dedicated user interface which allows the user to work through each stage step-by-step. This is the FTTH tab as shown on the next page.

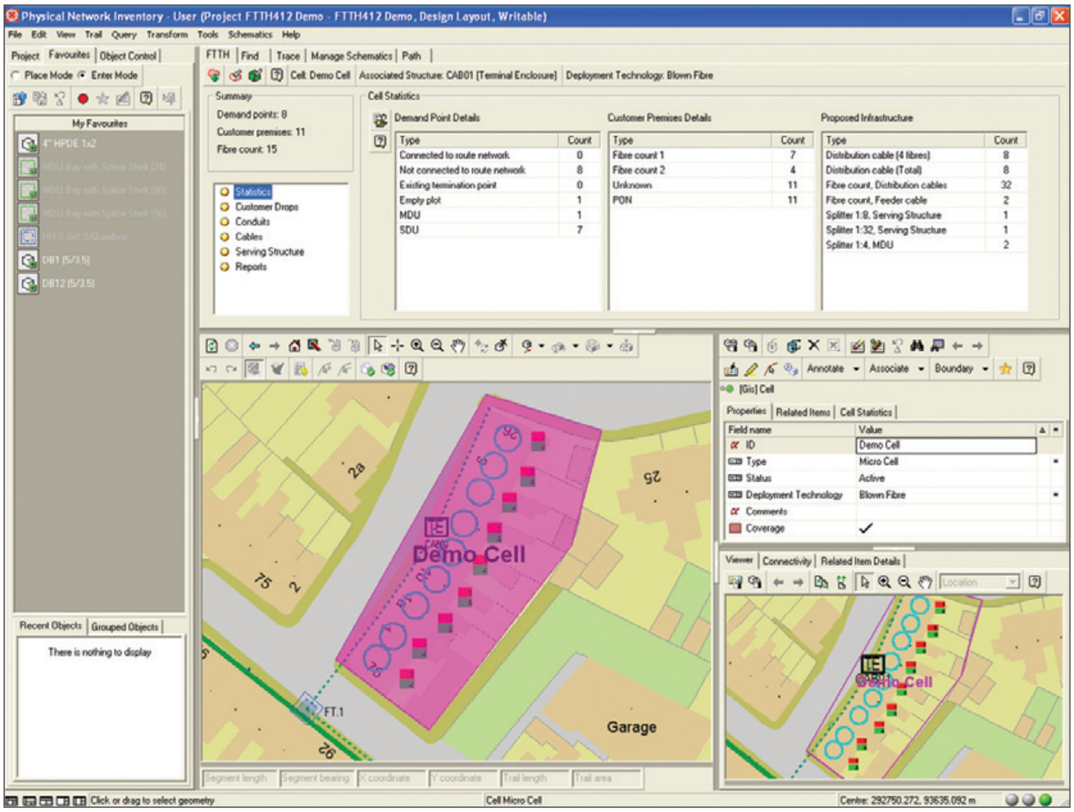
From strategic planning to detailed network design



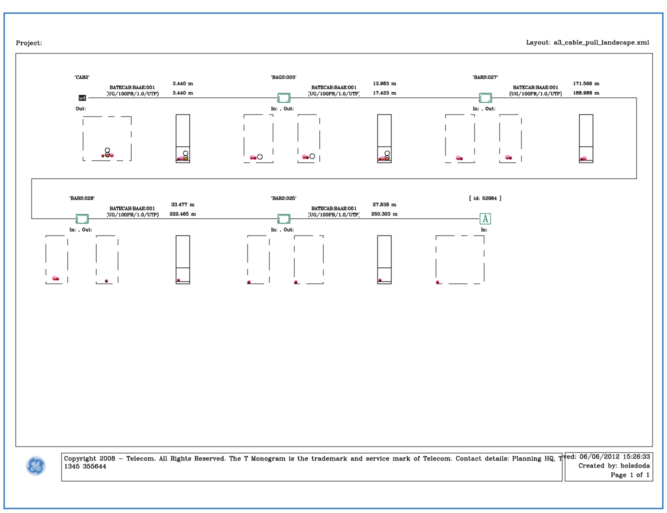
For a typical FTTH network, the cost savings from such an automated solution is staggering. It is estimated the cost of building a FTTH network is ~$1,000 per home passed, of which 5% is for network planning and documentation[6]. With ~70% savings[7] realized by users of the automated FTTH planning tool, this equates to savings of ~$35 per home passed – a savings of ~$3.5M for a 100,000 homes passed network.

The final step of the network design process is the generation of output from the detailed design process to instruct the construction crews what needs to be done and where. Physical Network Inventory includes a Report Pack capability. The Report Pack is created as a series of documents within a folder. These reports include a Bill of Materials, splice reports, schematics, cable pulling diagrams, manhole butterfly diagrams, trench cross-sections, etc. The Report Pack provides a highly extensible and customizable framework which simplifies the production of such report packs for the network designer into a single, simple to use, user interface as shown below.

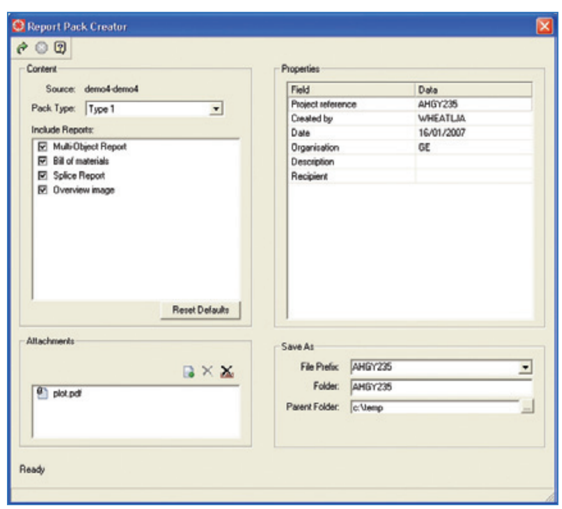
The output of the Report Pack is an XML document that can then be transformed into different formats such as Microsoft Word .doc or Adobe® Acrobat .pdf. For example, the screenshot below shows the output of the cable pulling diagram displaying which conduits a new cable needs to be pulled through.



Using Smallworld Physical Network Inventory to design a FTTH network



Output by Report Pack of the cable pulling diagram displaying which conduits a new cable needs to be pulled through



Generating report packs from Smallworld Physical Network Inventory

A sample view of the FieldSmart client

2.5 Network build

When the NGA network is built, support is provided for the update process to ensure the final as-built situation in the field is correctly reflected in the network inventory at the conclusion of the network build process.

The Mapframe FieldSmart solution introduced in §2.4 is the basis for the field solution. This solution provides construction crews with the ability to electronically update the designed network with the final as-built and to share these changes with the users in the office. A rigorous quality assurance process ensures the field changes are appropriately tested before they are accepted into the master inventory.

2.6 Service fulfillment

Once the NGA network has been fully constructed, broadband services must be delivered over the network to end customers to realize the return on the investment (ROI) of the network build. This service fulfillment process must be as streamlined as possible to ensure that maximum ROI is generated. A complex manual process would result in considerable delays, increasing time to revenue generation and, even worse, a lack of customer uptake.

A key element of any fixed line network is the physical connection between the customer premise and the serving location, which could be a central office or a street cabinet. Since the Physical Network Inventory system contains the entire physical infrastructure to support this connection, it is natural the Smallworld solution should provide the capability to generate the necessary physical path. Smallworld Physical Resource Assignment is a product that provides this capability. A simplified representation of the physical network (i.e., filtering the network resulting in a straight-line representation between points of flexibility in the network) is generated within Physical Network Inventory and passed to Physical Resource Assignment. This can then be used to automatically respond to a request for a physical path. When a request is received, Physical Resource Assignment identifies the customer's location and serving terminal (or if this is not available yet, then the closest network terminal) and then determines the physical path upstream from that point back to a main serving location, which could be a street cabinet or a central office.

For example, in the case of a Fiber-To-The-Home (FTTH) network, the Customer Facing Service runs from a port on the Optical Line Termination (OLT) to a port on the Optical Network Termination (ONT). Physical Resource Assignment is responsible for generating that physical path between these two ports.

Physical Resource Assignment will determine all necessary network connections (i.e., jumpers, cross-connects, splitter connections, etc. to construct the physical path). The path details and the work required to connect the path are then returned to the requesting system for further action, such as to hand off to a work management system to dispatch a field crew to make the necessary connections.

The benefits Physical Resource Assignment can realize can be divided into a number of different areas:

Operational benefits

- Enables prequalification of service provision to a customer location
- Increases 'first time turn up' of service based on fully connected physical network
- Reduces installation failure costs by reducing the number of required installation truck rolls
- Improves quality of service with more accurate provisioning
- Enables faster response to customer requests and improves customer experience
- Reduces network build costs by avoiding unnecessary network build

Cost of ownership

- Product solution avoids the need for a custom model and custom allocation engine, reducing related on-going maintenance costs
- Integration with Physical Network Inventory removes the need for complex integration projects between Physical Network Inventory and logical inventories, providing a cleaner architecture with faster performance

System architecture benefits

- Where a network operator is providing Layer 1 services to other operators providing higher level services, separation of the physical and service layers allows users to avoid interacting with multiple systems – all interactions can be managed through PRA
- The PRA architecture is well suited to the network company/ operating company separation, providing a clean system split that mirrors the operational split of the organization
- PRA can communicate northbound to multiple inventory systems, simplifying support of multiple service wholesalers and retailers or multiple systems for different technologies
- Built using industry standard tools and TMForum Information Framework, making integration with multiple systems from different companies simpler and cheaper

2.7 Service assurance

Once the NGA network is operational, network maintenance (both proactive and reactive) is critical to provide high-quality customer service. This includes quickly and accurately locating the root cause of network failures and providing work crews with information and directions to resolve the fault. It also covers the planning of longer term proactive maintenance programs to avoid problems before they occur.

Therefore, support for service assurance processes is another key aspect provided by Smallworld Network Inventory. Again accurate data about the network (e.g., where it is, how it is connected) is vital to ensure rapid response to network alarms, reducing network downtime and improving customer care by providing customers with better network information and proactive reporting of faults. Benefits reported by operators include improved network fault location from 12 hours average to less than an hour (92%) and improved alarm location time from two hours to five minutes (96%).

Support for service assurance is provided in a number of different areas of the product portfolio:

Physical Network Inventory

A number of specific APIs are available, which provide support for geographic fault location though OTDR measurements. These APIs are exposed as Java Messaging Services and can be easily accessed. Different services will return different information. For example, a map showing the route of the network trace and the location of the fiber break, the coordinates of the fiber break, or a KML file that can be loaded into Google® Earth to view the route of the cable and location of the break.

Network Inventory Gateway

Network Inventory Gateway provides a simple to use web-based user interface for accessing the data held in Physical Network Inventory. This is ideally suited to users within a Network Operations Center who do not need the full capabilities of Physical Network Inventory. Network Inventory Gateway provides tools to perform OTDR tracing on fiber networks, and the results can be visualized and exported as required.

Mapframe FieldSmart

Mapframe FieldSmart allows full round-trip management of network data. Field users can have access to the entire network database of record on a single device with no need for network connectivity – ideal in outage situations. This gives the field technician all the data needed to identify and resolve network faults. Additionally field users can document any changes made in the field, and these changes are returned to the office to incorporate into the inventory under a rigorous quality assurance process.

Field Force Automation

Field Force Automation is a workforce management system that provides support for scheduling and dispatching field crews. This advanced solution allows operators to effectively manage their field crews, especially during an outage event.

3 Customer case studies

As mentioned, a number of Smallworld operators are successfully deploying NGAs supported by their Smallworld solutions. Below is a short summary of a number of these operators.

Major European incumbent operator

One of Europe's most innovative incumbent operators is currently deploying a direct point-to-point FTTH network countrywide. This is a significant undertaking, and their intent is to collaborate with other suppliers or operators within a specific region, such as the local electrical supplier, in order to share the cost burden.

Physical Network Inventory is a fundamental building block of the OSS that will deliver the new FTTH services. In 2008, the operator captured their new FTTH infrastructure in Physical Network Inventory . Then in 2009 they deployed the Smallworld FTTH Module to realize significant productivity savings in the design phase of the rollout. In 2011, the first phase of a major integration activity went live integrating all systems that are critical to the rollout and operation of the Next Generation Network (NGN) services based upon the FTTH network.

Netcologne

Netcologne is a regional landline provider in Germany delivering broadband services to residential and business customers via Fiber-To-The-Building (FTTB). The fibers are blown from the local hub to each building and then in-building copper network is used to provide a DSL connection to the customer premise. This architecture is well suited to the situation in Cologne, where the majority of customers live in multiple dwelling units. Their Physical Network Inventory deployment has been critical to managing their inside and outside plant network, creating a central database of information supporting planning, engineering and operations. This has dramatically improved their planning, with 100% increase in productivity. Now, the process to resolve network faults is 100% faster using Smallworld Network Inventory.

Fastweb

Fastweb was one of the first companies in the world successfully supplying high bandwidth services using IP over a fiber-optic network. The Fastweb network is mainly a Fiber-To-The-Home network, with fiber-optic used up to the final connection to the customer. One of the main FTTH deployment challenges arose from the prevalence of multiple dwelling units typical in many Italian cities; this imposes an accurate network information management on different layers from the horizontal one up to the vertical trunks reaching each final customer. Fastweb's deployment of Physical Network Inventory has been a key element to managing the rollout of the fiber network and has enabled them to pre-provision property connections, allowing Fastweb to offer its customers' activation of service within a few days.

Major European incumbent operator

One of the largest incumbent operators in Europe has been a Smallworld customer since 1996, and Physical Network Inventory supports the core business processes of planning, build and operation of the physical network infrastructure. It supports all outside plants and is used for the copper and fiber access network and the fiber transport network.

In 2010, the management team opted for a FTTH mass rollout starting in 2011 with the target that 10% of households will have FTTH by the end of 2012. This represents approximately 4 million households.

Such a massive rollout of FTTH requires a huge amount of network design. Physical Network Inventory is the central solution for the inventory of the existing physical network and also the basis for all planning of the new FTTH network. The operator has opted to deploy a Passive Optic Network, and this will be largely direct buried (as much of the copper network is) or will be deployed using blown-fiber technology.

The operator has deployed a fully automated high-level design tool, which is directly integrated with Physical Network Inventory to ensure its ambitious rollout targets can be met. This allows planners to make rapid cost estimates to support the decision to build, rent, or stop deployment for a given area. The deployment costs can be dramatically reduced by utilizing existing infrastructure, such as free conduits which are documented in Physical Network Inventory . The key benefit is to reduce time-to-market for these new services to allow the operator to meet its goals.

Chorus

Chorus is New Zealand's largest telecommunications utility company. It maintains and builds a network predominately made up of local telephone exchanges, cabinets and some 1.8 million copper and fiber optic lines connecting homes and businesses throughout the country. Its open access network and innovative new wholesale products and services are used by many different phone and internet service providers, helping them to deliver the services their customers rely on.

Chorus is the cornerstone partner in the New Zealand government's Ultra-fast Broadband (UFB) initiative and will deploy fiber-to-the-premise across 24 local regions, which represents around 70% of the total UFB coverage area.

Chorus has used the Smallworld Physical Network Inventory platform to manage its existing network for many years and more recently helped it to deliver its urban Fiber-to-the-Node broadband upgrade. Physical Network Inventory will now play a key role as a central design and documentation solution for building Chorus' new UFB network.

Chorus has deployed the Smallworld FTTH Module on top of Physical Network Inventory to speed up the design of the UFB network.

4 Conclusion

The potential rewards and challenges facing network operators as they transform their networks to a Next Generation Access network are truly staggering. To realize this future vision, a geospatial network infrastructure system, such as GE's Smallworld solution, closely integrated with the operator's other Operational Support Systems, is critical.

GE customers are using the Smallworld Network Inventory product portfolio to address these needs. Our highly scalable product set supports an impressive list of more than 120 service providers across 37 countries worldwide, including large and established national telecommunications operators, cable multi-service operators, competitive service providers, long haul carriers and mobile operators.

The benefits realized across these process areas through the use of Smallworld Network Inventory can be significant. The following table summarizes these benefits[8] from each of the process areas outlined in this paper.

PROCESS	KEY BENEFIT	EXAMPLE CUSTOMER BENEFIT
Strategic planning	Utilizing existing network capacity leads to reduced new network build	Up to 20% reduction in new build costs
Network planning	Rapid estimation of build costs and optimized network plans	Up to 30% reduction in planning time for major network upgrades
Network design	Accurate, cost effective network planning	Up to 40% productivity improvements
Network build	Enabling as-built updates to be completed in the field and electronically transferred to back office staff	Up to 15% savings in workforce productivity
Service fulfillment	Accurate knowledge of the "service ready" network to support customer service provisioning	Up to 50% savings in provisioning time
Service assurance	Improved service assurance through faster fault location	Up to 25% reduction in network downtime

References

1. 2010/572/EU: Commission Recommendation of 20 September 2010 on regulated access to Next Generation Access Networks (NGA) (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32010H0572:EN:NOT)
2. Source - http://www.ispreview.co.uk/story/2011/09/27/study-claims-doubling-broadband-isp-speeds-positively-boosts-gdp-by-0-3-percent.html
3. European Commission Digital Agenda Scoreboard 2011 http://ec.europa.eu/information_society/digital-agenda/scoreboard/index_en.htm
4. Source Telecom Paper February 2012 http://www.telecompaper.com/news/global-ftthb-subscribers-reach-67-mln-at-mid-2011
5. Source ABI Research press release July 2011 "Update: Fiber Broadband Subscriptions to Double by the End of 2016"
6. Heavy Reading FTTH Worldwide Technology Update & Market Forecast Vol 6 No. 1 February 2008
7. Figure based on benchmarks carried out by Physical Network Inventory customers piloting the Smallworld FTTH Module
8. These savings are based on real customer examples included in GE case studies or presented at GE conferences.

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