Utility Network- The next generation solution for Utilities

Suman Dasgupta [1], Surya Srinivas Chavali[2]
[1] Principal Consultant, Infosys Limited
[2] Principal Consultant, Infosys Limited
Sez Survey No. 41-50, Pocharam Village,
Singapore Township, Ghatkesar, Ranga Reddy
PIN 500088

Abstract:

Utility Network- The new platform for GIS solutions for Utilities will change the way the assets are being managed and maintained in the system. Utility network will address some of the complex problems, provide solutions, and can be a business enabler. The change from the existing platform to the new Utility Network is transformational in nature. It encompasses business process changes, applications development, database migration, refreshing GIS integration touchpoints and change management. The new solution will change the ArcGIS-Geometric Network nexus that was ruling the Utility customers on Esri towards a more advanced Pro- Utility Network combination due to the change in need, demand and the way the customers manage the assets today.

The paper will highlight the key advantages of the new platform, highlighting the key changes and differentiators, and a high level view of how to achieve the transformation with minimum risk, zero downtime and maximizing the impact. From the POC and prototypes done so far it has been established that the existing GIS needs to be future ready before taking the big leap towards the Utility Network. And there is no single model that would fit all. The model mentioned here is a derived from similar prototypes done for several utility customers across the world.

About the Author:

Mr. Suman Dasgupta

17+ years of experience in analysis, design and implementation of Enterprise GIS solutions, and implementing spatial analytics for various clients worldwide. Has played a key role in helping organizations establish and accomplish their strategies, and design roadmap for Enterprise GIS integrated with several other systems.

E mail ID: suman.dasgupta@infosys.com

Contact: +918142000513

Mr. Surya Chavali

18+ years of Experience in consulting and implementing large programs in TnD, Mobility and GIS space across different geographies. Leading the Infosys Delivery in Consulting practices for complex implementations in this space.

E mail ID: suryas_chavali@infosys.com

Contact: +919100440058

Introduction

The latest buzz in the Esri's Utility Domain is Utility Network. Technology @ Esri is changing, as ArcGIS desktop is being taken over by ArcGIS Pro, Server Applications are getting more aligned towards Portal for ArcGIS, mobile Apps are getting more and more important, and the ability to do GIS "the science of where", from anywhere at any time, and on any devices is gaining momentum. The ArcGIS horizon that was set in the beginning of 2000 is witnessing a paradigm shift in terms of the technology stack and the way people needs GIS now in their business operations.

With the emergence of new platforms and technologies, GIS is no longer perceived as a separate system, it will be rather a spatial enablement of systems across all application stack and technology platforms.

The journey to the Utility Network platform is complex and transformational in nature. It is an amalgamation of various processes, at functional and technical level.

Through our extensive experience in dealing with multiple Utility customers, we have taken up the prototypes to Utility Network transformation on customer specific datasets, and evaluated the changes that they would experience in the new system. This is backed up by learnings from several knowledge sessions, user conferences, Developer summits all over the world.

The current paper highlights some of the advantages of the new platform, the intricacies and what might be the actual path for the transformation journey. The proposed transformation approach is based on the results of the prototypes conducted, and the knowledge gathered from several industry forums. The approach and value might slightly differ depending on the customer business priorities, future directions and roadmap. However the key essence of the journey is to be "future ready", so that all risks to the transformation is covered and there is minimal impact to business.

Advantages and key value differentiators

Following are some of the key value differentiators of the new platform:-

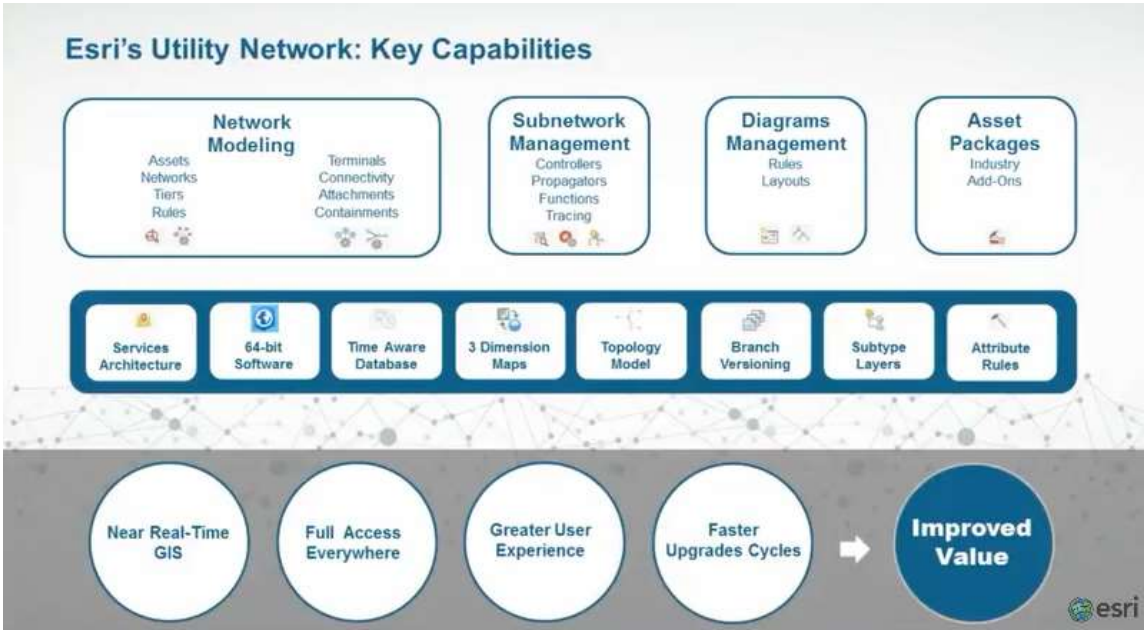
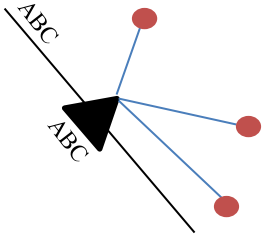


Fig: 1 – Utility Network Offerings

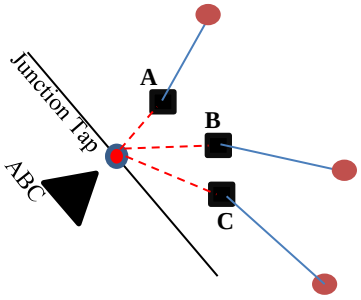
Source: www.esri.com

- Better spatial representation of objects: Unlike its predecessor, all the assets that are a part of the network are spatially represented in the map. Example the transformer or Fuse units which were depicted as objects are captured as features in Utility Network. This helps in mapping individual assets and customers to the parent objects.
- Advanced analytical capabilities that includes but not limited to the following:
  - ✓ Inside plant schematics- representing the individual assets within a substation (Electric) or Regulator Station (Gas)
  - ✓ Stepwise tracing across different voltage levels (electric) or pressure zones (gas or water)
  - ✓ Structural Attachments- Connectivity between Network and non-network objects i.e. association between a Pole and transformer bank within one or different networks (i.e. same Power Pole shared by Distribution and Transmission Network). This is an example of logical connectivity between network and non-network objects.
  - ✓ Containments- Link feature classes as a containment of the parent object i.e. transformers contained by a transformer bank, or assets that are contained by a substation object. The parent-child objects in the containment are logically connected.
  - ✓ Ability to represent one of more connection point on a device in the form of connection points. They support more realistic representation of devices which would help in a variety of complex situations like source-sink scenario, high and low side for analytical purpose (e.g. Distribution Step down transformers), asymmetric traversal (check valve) etc.
- Seamlessly work for Transmission and Distribution Network or between network types e.g. Water and Gas. The different types of network can be connected, yet logically separated from each other.
- Detailed attribute and connectivity rules are built within the Utility Network framework. The connectivity rules are governed by Esri topology framework that would prevent any incorrect data updates in the system. The attribute rules powered by cross platform Arcsde expressions operate at an attribute level for validation and auto-calculation of attributes. The rules can be customized based on customer specific scenarios.
- The solution is enriched with advanced editing capabilities in complex editing scenarios (feature templates). This allows placement of features grouped together as assemblies (Bus bar assembly) within built-in snapping and connectivity rules.
- The new solution is fully service based taking a stride from client-server based architecture, making all applications and offerings platform and device agnostic. So the same set of functionalities and capabilities can work across desktop, web and mobile platforms.
- Increased performance- 5x faster than the current platform. The Utility Network framework because of its architecture and design offers a faster performance
- New versioning capabilities- partial posting, reduced states etc. With this offering there a new concept of versioning- that is transactional nature. The new versioning concepts gets rid of the states and branches in A and D tables.
- Collaboration with real time events and big data is much easier to achieve providing powerful analytical capabilities.
- All objects in the Utility Network Data model are 3D enabled offering powerful 3D mapping and analytical capabilities
- Utility network also support Linear referencing that helps to isolate and find out sections of pipes in the network that are likely to be impacted due to damages.

The following example below shows difference between the objects mapped in geometric and utility network:-



Geometric Network: Connectivity established directly between the Transformer Bank and the secondary Conductors, Transformer Units are records within the object table and not a part of the network directly.



Utility Network: Network Association shown between the Junction point and the individual transformers (red line). Both transformer bank and transformer units are captured as features

Fig: 2 – Spatial Representation of objects in Geometric and Utility Network

Data Structure

The Utility Network data structure differs from the existing data structure and layout in Geometric Network. Instead of mapping objects into different feature classes and objects, the utility network data objects are mapped into five categories, and each asset is derived as a sublayer from that category. Following is a high level diagram of the Utility Network Data model.

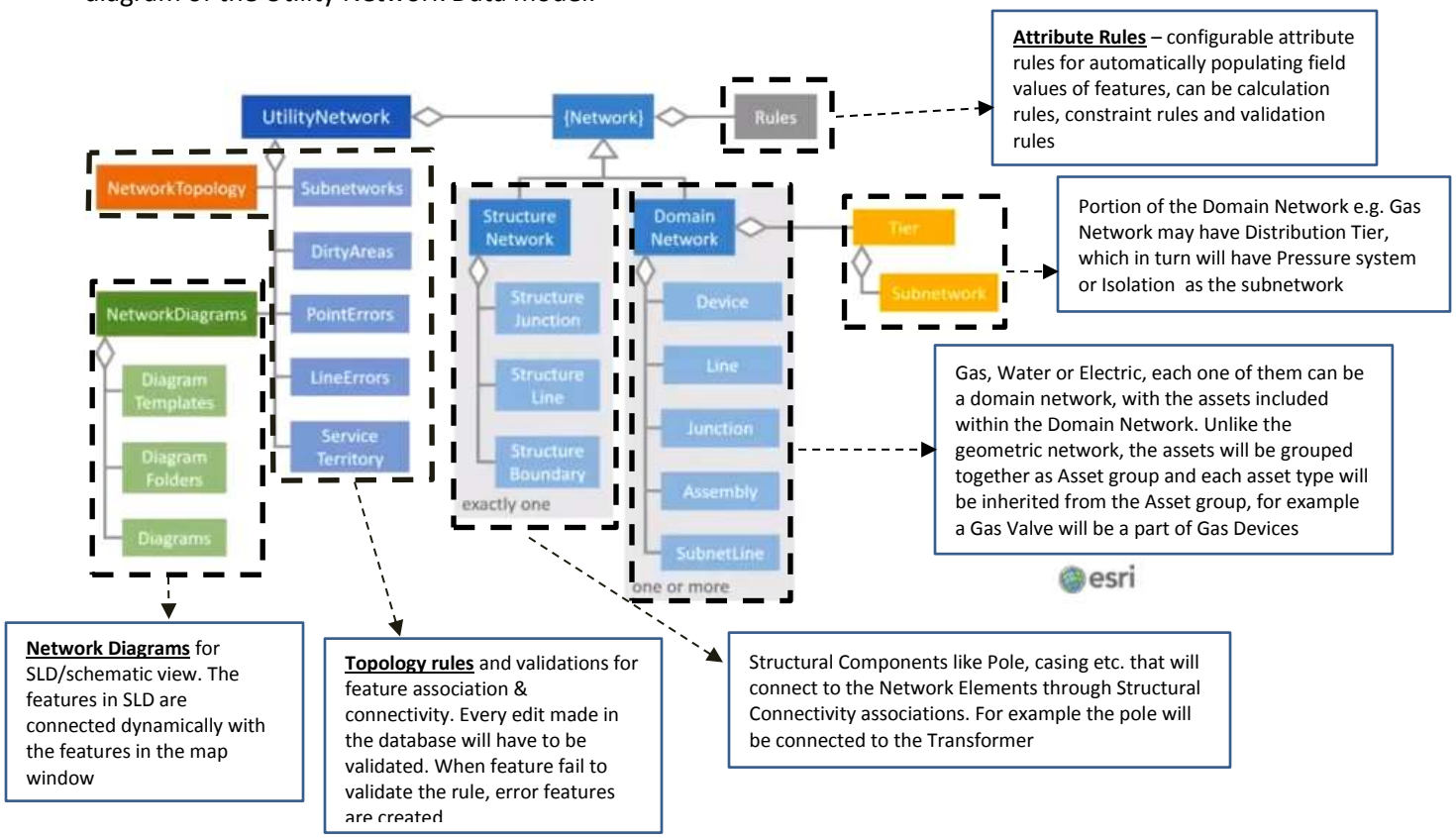


Fig: 3 – Utility Network Data Model

While Geometric Network primarily relies on logically grouping of objects into Electric, Water, Waste water or Gas Domains, Utility Network categorizes the objects into different Domains. So in a geometric network the objects can be logically grouped into Electric Network and all assets within the network are grouped into different feature classes and related tables. The different asset types represented in the geometric network need to be physically connected.

In Utility Network, the objects are grouped into different asset types within each of the domains. The Domains (e.g. Electric, Water or Gas) can be interlinked with cross domain trace functionalities, different domains sharing the same structural network. Not all objects in the Utility Network need to be physically connected, the connectivity rules are based on a combination of physical and logical connectivity.

The following diagram shows a high level view of how differently the objects are mapped in the Utility Network unlike its predecessor- Geometric Network

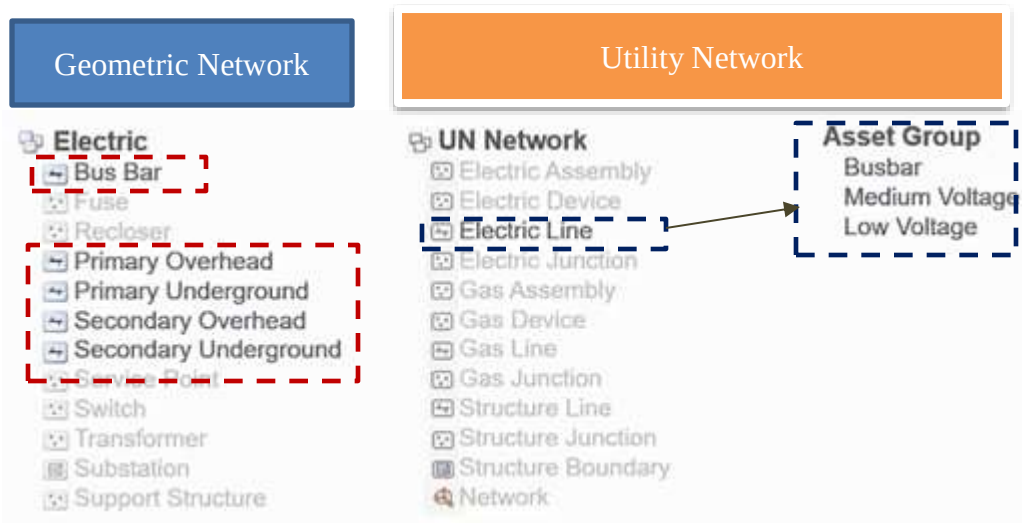


Fig: 4 – Utility Network Data Model Comparison- Example

Design Considerations

The Utility Network Suite is services based, there is no direct connect to the database from the application, all connection to the data elements from ArcGIS Pro will be through services. The different kinds of services used in Utility Network are Feature Service (data access and editing), Utility Network Service (tracing and other Utility network analysis), Network Diagram Service (generate and maintain Network diagrams and SLDs) and Version Management Service (new transactional versioning principles including options for partial posting).

Fig: 5 – Service architecture in Utility Network Management

As mentioned earlier, The Utility Network offering is cross platform, implying that it will work across all the platforms: web, desktop and mobile. The services based architecture enables the users to have access to all tools (including the complex tracing tools) across all platforms.

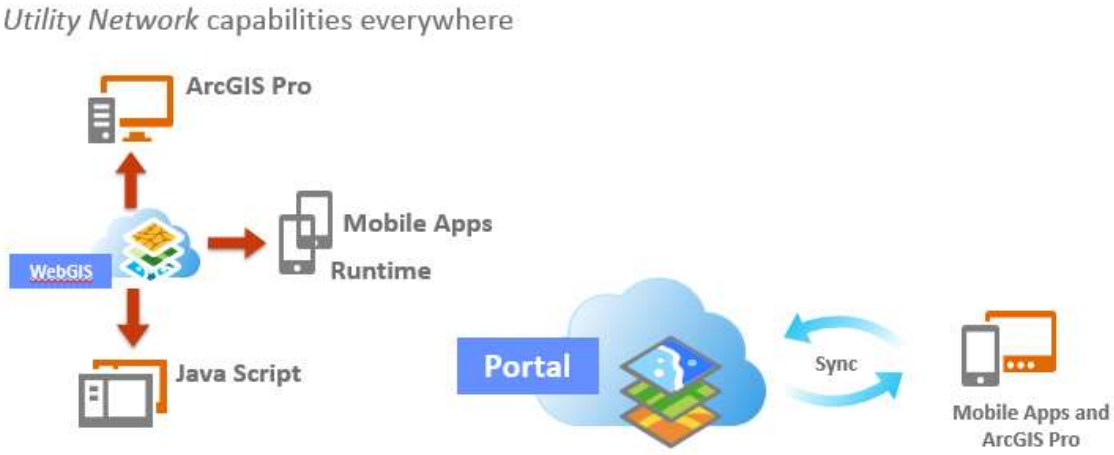


Fig: 6 – Utility Network Capabilities

The Transformation journey

The Utility Network migration should include all the key stakeholders and the processes within the system. Today GIS is an integral part of majority of the applications within the Utility companies. All applications are spatially aware, so it is important to know which pieces will be taken up in the sequence as the transformation journey commences. There can be a big bang transformation to bring all the data elements and some of the key application components in the Utility Network, and establish a process such that incremental updates keep coming in from the existing editing environment until the editing apps are all moved to the new framework. The figure below shows a high-level approach for the migration. The GIS vendors, users and System Integrators all have an important role in this ecosystem. The platform transformation would also mean redesigning and redeveloping some of the key interface components that point to non-GIS applications and systems (like Work and Asset Management Systems, Billing, CIS etc.)

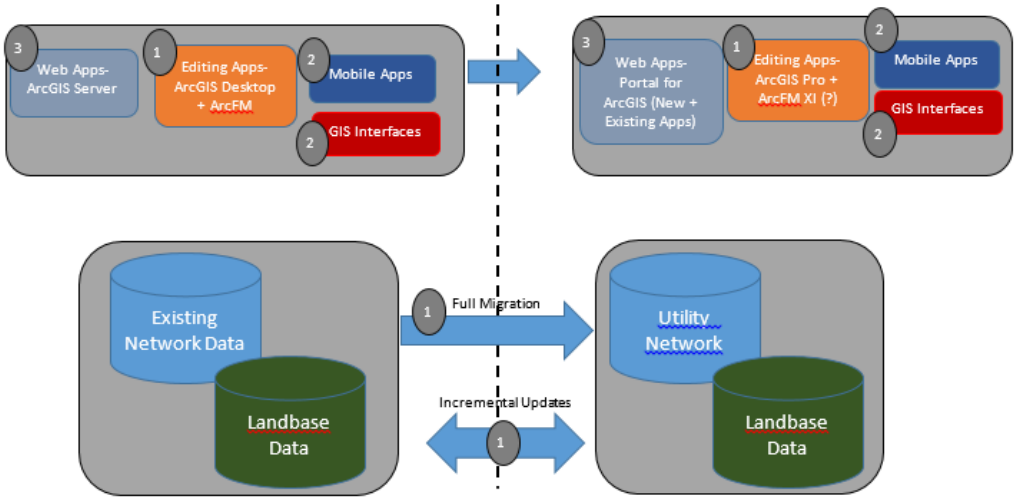


Fig 7: Migration to Utility Network (Numbers indicate the sequence/order in which the migration of data/Apps should be taken up

The recommended approach would be to get all the editing components together followed by the read-only components. Some of the read only mobile Apps and interfaces can be pushed to a later release depending upon the priority of the business.

The above diagram shows one approach for the migration, however it would vary between organizations, depending on the GIS outreach and the scale. Due diligence is important before undertaking such an initiative. It is recommended that the organization conduct a small prototype (maybe a circuit/feeder or a pressure zone that is representative of all the key components and objects of the data model), assess the impact and then plan for the transformation journey.

The plan for the transformation journey might span across close to a couple of months following an iterative approach of prototypes, Pilots and final migration iterations, each cycle refining the process for the next run.

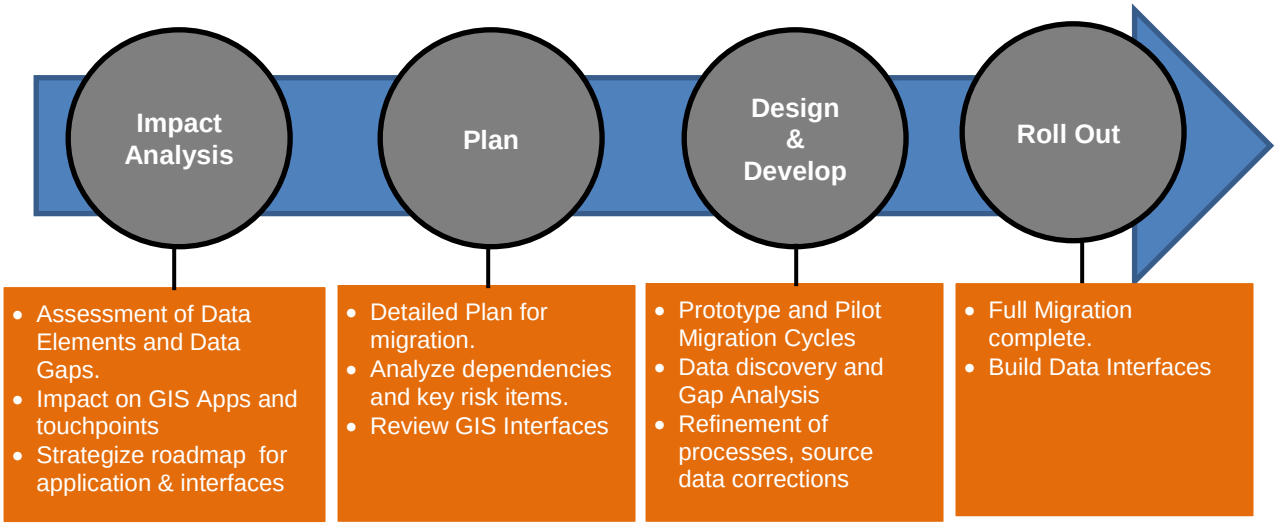


Fig 8: Utility Network Migration plan

The results from Prototype migration of Utility network have shown that the new application on Utility Network datasets is actually much faster as compared to the existing ArcMap application working on a geometric network. Also given the fact that all objects are accessed through feature services (instead of the traditional client-server based DB access approach), the number of chatty calls to the DB is very low, which makes the queries much faster on the client side. The new method of de-normalizing the tables in Utility Network reduces the number of joins and nested queries that the earlier versions of database was using.

The start of the transformation needs a proper consideration and review of the existing GIS and all the related systems. The recommended approach would be to conduct a pilot/prototype to understand the impact encompassing all the possible factors, risks and parameters, and be "future-ready" before the actual transformation.

Conclusion

Utility Network is a leap towards the utilities GIS built on the Esri platform. Implementing Utility Network will provide the GIS organization with a more real-time depiction of objects coupled with powerful analytical capabilities. The utilities today need to plan and embrace for the inevitable change that will serve them for good in the long run.

References

1. https://www.youtube.com/watch?v=BwThh93YAxc: *Insight into the Utility Network explained by Eric Hoel and Tom Brown*
2. *http://www.esri.com/esri-news/arcnews/spring17articles/introducing-utility-network-for-arcgis*