Managing Utility and Telco Networks with ArcGIS

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Network Management Session

• Presentation Agenda
  - Overview
  - Why you want a Utility Network?
  - What exactly is a Utility Network?
  - How will you perform analysis against a Utility Network?
  - What are the capabilities of a Utility Network?
  - Additional platform benefits
  - Road Map… When will you have a Utility Network?
Enterprise GIS for Utilities and Telecoms
A Platform for Collaboration, Integration, Analytics, Innovation and Dissemination

Web GIS for Utilities and Telecoms

Data Management
Sharing / Business Groups
Apps for Staff and Contractors
Business Integration
Geo-Analytics

Rapid, Agile Extending ROI
Road Map for Utilities with ArcGIS

1. Setup Portal for your organization
2. Move to ArcGIS for Desktop 10.2.1
3. Make use of ArcGIS for Utilities
4. Move to the Utility Network
5. Stay on top of platform improvements/GeoEnable your organization

A little further down the road
Continued Support for ArcGIS 10.2.1

Improving ArcGIS for Desktop 10.2.1

- Utilities and Telecom Update 1 Patch – August, 2014
- ...
- Utilities and Telecom Update 7 Patch – January, 2017
- Utilities and Telecom Update 8 Patch – planning now
- Windows 10 Update Patch – January, 2017

Working on certification of 10.2.1 with:
- Windows Server 2012 R2 Update – under consideration
- Windows Server 2016 – under consideration
- Sql Server 2016 – included with UTUP 7
- Citrix XenApp 7.7
Network Management Project

• New *Utility Network* for the next 15+ years
  • Electric, gas, water, storm water, sewer, telco, etc.
Vision statement

- Provide utility customers the ability to **model, edit, and analyze** complex networks leveraging the entire *Esri* platform
- Enable modeling concepts to better support true representations of what is on the ground, while fostering an easy exchange of network information with other mission critical systems
- Provide a highly responsive editing and analysis environment
Continued Growth of the Platform
Extending network capabilities throughout the platform

Information Technology
Foundation Apps and Essential Information Products for Rapid ROI
Leverage services, API’s, SDK’s to geo-enable ERP, BI, WMS, CRM
Corporate Authoritative “GIS Network” Data

Operational Technology
Extended / Custom Apps for Advanced Workflows
Leverage CIM, GeoEvent, etc. to geo-enable DMS, OMS, AMI, SCADA
Commercial Content

Utility Network
Transaction Model
Editing Tools
Attribute Rules
Online Content and Services
Why would you want a utility network?
Keys to Network Management

• *Increasing your ROI*
  - Services based architecture for enabling the platform
  - Ensuring data quality and correctness
  - Real world representation of what is on the ground
  - Sophisticated analysis
  - Subnetwork management
  - Improved mapping and visualization techniques
  - Expanded data exchange capabilities
  - Increased performance
  - A strong foundation for our *customers* and *partners*
Keys to Network Management

- Services based architecture for enabling the platform
  - Desktop capabilities
    - Visualize and query - mapping both geographic space and diagram
    - Editing - Advanced tools and templates
    - Analysis - complex processing with geoprocessing with reporting
Keys to Network Management

- Services based architecture for enabling the platform
  - Runtime and Offline capabilities
    - Visualize and query – mapping both geographic space and diagrams
    - Edit – perform edits in the field from inspections to simple design
    - Analyze – determine upstream device or valves to turn for an isolation while in the field
Keys to Network Management

- **Services based architecture for enabling the platform**
  - Web capabilities
    - Dashboard capabilities for executives
    - Thin client applications on the desk of everyone in the organization
    - Provide simple outage maps to consumers
  - Online capabilities
    - Reducing administration and cost of ownership, etc.
Ensuring data quality and correctness
- Quality of data becoming increasingly important to drive smart grid and external systems
- Reduce common data collection errors through...
  - Feature placement based on predefined patterns
Keys to Network Management

- Ensuring data quality and correctness
  - Quality of data becoming increasingly important to drive smart grid and external systems
  - Reduce common data collection errors through…
    - Automated snapping based on connectivity rules

Define connectivity rules
Choose template
Sketch new feature in constrained environment
Keys to Network Management

- Ensuring data quality and correctness
  - Quality of data becoming increasingly important to drive smart grid and external systems
  - Reduce common data collection errors through…
    - Automatic attribute update based on defined scripts and expressions

If [Lifecycle_Status] = “Abandoned” then [Pressure] = “None”
Keys to Network Management

- Ensure data quality and correctness
  - Quality of data becoming increasingly important to drive smart grid and external systems
  - Eliminate connectivity errors through rules and validation
Keys to Network Management

- Real world representation of what is on the ground
  - Accurately representing assets for enhancing analysis and modeling and for simplifying data export for other systems
  - Device Assembly – A container for multiple devices…
Keys to Network Management

• Real world representation of what is on the ground
  - Accurately representing assets for enhancing analysis and modeling and for simplifying data export for other systems
  - Linear containment – Trenches/Ducts contain wires…
Keys to Network Management

• Real world representation of what is on the ground
  - Accurately representing assets for enhancing analysis and modeling and for simplifying data export for other systems
  - Terminals – modeling real world connections…
Keys to Network Management

- Sophisticated analysis
  - ArcGIS Pro provides basic pre-configured tools in the gallery
    - Connected
    - Subnetwork, Subnetwork Sources
    - Upstream, Downstream
    - Loops
  - Partners and users can modify the gallery
    - Adding and removing pre-configured tools
Keys to Network Management

- Subnetwork Management
  - Representing a portion of the network, a “Pressure Zone” or “Circuit”
Keys to Network Management

- Improved mapping and visualization techniques
  - Diagram capabilities integrated directly with the *Utility Network*
Keys to Network Management

• Improved mapping and visualization techniques
  - *Utility Network* is 3D enabled
Keys to Network Management

- Improved mapping and visualization techniques
  - Ability to define an active subnetwork
Keys to Network Management

• Expanded data exchange capabilities
  - Expanded core capabilities mean more opportunities to do modeling and high end analysis inside the GIS.
  - Many workflows will still require moving data outside the GIS to other mission critical systems.
  - *Esri* will support these options for exporting data…
    - Export to Well Known Text
    - Export to CIM format (connectivity information only)
    - Export to connectivity table
    - Export to Geodatabase feature classes
    - Export to Json
Keys to Network Management

• Increasing performance
  - ArcGIS Pro, multi-threaded map display and processing
  - Editing tools for increasing productivity…
  - New ArcGIS Pro display cache
  - New optimized subtype layer (fewer spatial queries - scalability)
  - New rendering techniques per symbol (display filters/visual variables)
  - Efficient tracing w/ structure networks embedded into the topology
  - New versioning model (very efficient query model – single tables)
  - Ability to resolve conflicts across multiple editing sessions
  - Ability to support synchronous posting operations
    - Partial posting!
Keys to Network Management

- A strong foundation for our Customers and Partners
  - Better core framework means better starting point for partner solutions

Utility and Telco Solutions

- Partner Solutions
  - Esri Solution Templates (starter capabilities)
  - Network Management Framework
  - ArcGIS Platform
Why exactly is a utility network?
Utility Network - Domain Examples

- A *Utility Network* is composed of one structure network and one or more domain networks
  - Domain examples

<table>
<thead>
<tr>
<th>Electric</th>
<th>Water</th>
<th>Combined Sewer/Storm</th>
<th>Gas</th>
<th>Domain Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission network</td>
<td>Transmission network</td>
<td>Sewer network</td>
<td>Gas network</td>
<td>Partner provided models</td>
</tr>
<tr>
<td>Distribution network</td>
<td>Distribution network</td>
<td>Storm network</td>
<td>Structural network</td>
<td>Core generic model</td>
</tr>
<tr>
<td>Structural network</td>
<td>Structural network</td>
<td>Structural network</td>
<td>Cathodic protection network</td>
<td></td>
</tr>
</tbody>
</table>
Demo: Utility network overview
Utility Network – Structure Network

- Structure network represents features that support or contain devices and/or lines
  - Poles or transmission towers support lines and devices which are attached
  - Conduits and ducts contain cables and wires
  - Vaults contain devices
- Structures are shared between domain networks
- Structure network can be traced
  - Find available space in conduit for another cable, etc.
Structure Network - Classes

- Structure network has three feature classes
  - StructureLine
    - Trench, Conduit, Duct…
  - StructureJunction
    - Poles, Tower, Manholes, Pad…
  - StructureBoundary
    - Substation, Bay, Vault…
Domain Network - Classes

- Each domain network has five feature classes
  - DistributionLine
    - Subtransmission, Medium Voltage, Low Voltage…
  - DistributionDevice
    - Fuse, Switch, Transformer…
  - DistributionJunction
    - Riser, Ground, Connection Point…
  - DistributionAssembly
    - Transformer Bank, CircuitBreaker Bank…
  - DistributionSubnetLine*
Utility Network – Tiers

• Within each domain network, there are tiers
  - A tier contains collections of features that form groupings that represent logical subnetworks that deliver the domain commodity
  - Each subnetwork has a source or sink
  - A large network can contain tens of thousands of subnetworks

• Structure networks do not have tiers, subnetworks or sources/sinks

• Analysis supports tracing across tiers

Electric

Transmission network
- High voltage tier

Distribution network
- Medium voltage tier
- Low voltage tier
- Low voltage mesh tier

Structure network
Utility Network - Gas Tier Examples

Gas flow

W - Wellhead
C - Compressor Station
TB - Town Border Station
R - Regulator Station
M - Customer Meter

Gathering
Transmission
Distribution

Pressure Subnetwork
Isolation Subnetwork

Pressure 1
Iso 1
Pressure 2
Iso 2
Pressure 3
Iso 3
Pressure 4
Iso 4
Pressure 5
Iso 5
Iso 6
Iso 7
Iso 8
Iso 9
Iso 10
Subnetwork Management - Overview

• Subnetworks are connected sub-portions of the network used for...
  - Analysis operations
  - Labeling/annotation, map making
  - Assigning units of work
  - Visualization (“active” subnetworks)
  - Exporting portions of the network

• Subnetworks correspond to circuits in electric, and pressure zones in gas or water
  - Structure networks do not have subnetworks
Subnetwork Management - Export Subnetwork

- The Geoprocessing **Export Subnetwork** tool is used to export a subnetwork to use in external systems
- Multiple output formats
  - Json, CIM, Geodatabase feature classes
Rule based engine

- **Utility Network** can be configured with or without rules
  - No rules present allows one to quickly move from existing non-rule based systems (Geometric network) to start prototyping **Utility Network** data models and behaviors
  - Once **one rule** is added, the system (validation) requires rules to create connectivity and associations
How will you perform analysis against a utility network?
Tracing Concepts - Overview

- Tracing is exposed in ArcGIS Pro as a Geoprocessing tool, the managed SDK, and REST with the Utility Network Analyst service
  - Pro will come with basic preconfigured tools in the gallery
  - Partners and users can modify the gallery
    - Adding and removing pre-configured tools
Tracing Options

- **Example:** *Include Containers (Subnetwork Trace)*

- For each feature that is content, include its container…
Tracing Options

• **Example:** *Include Structures (Subnetwork Trace)*

• For each feature that is an attachment, include its structure…
Tracing Options

• **Example:** Include Feature Status Override (Subnetwork Trace)

• Apply each feature’s status override value…
Basic trace parameters

• *Network Attributes Filters* define what constitutes traversability
  - Example
    - Trace downstream in a sewer network, finding all connected sewer mains where the main is 24” or larger and the main is made of concrete
  - Network Attributes
    - pipeSize
    - materialType
  - Filters
    - (pipeSize > 24) AND (materialType = "Concrete")
Basic trace parameters

- **Functions** are used to calculated statistical values during tracing operations
  - Available **Functions**: SUM, SUBTRACT, AVERAGE, COUNT, MIN, MAX
  - Functions can be combined with **Network Attribute Filters** and **Terminators**
  - Example
    - *Trace the connected structure lines and sum the length*
Basic trace parameters

• *Terminators* indicate when traversal should stop

• Three options
  - *Categories*: when a feature based on its assetgroup and assettype has a category assigned (Protective)
  - *Function*: when the function value meets or exceeds a network attribute value
  - *Network Attribute*: when the specified network attribute value meets the specified condition and value
Basic trace parameters

- **Output Filters** limit the result set
- Two options
  - **Categories:** when a feature based on its assetgroup and assettype has a category assigned (Protective)
  - **Asset Groups:**
    - Example: Only return elements from upstream/downstream trace results that have the “Protective” category
Demo: Tracing Experience
What are the capabilities of a utility network?
Connectivity Associations

- *Utility Network* connectivity is based on x, y, z

- Connectivity associations are used to model connectivity between two devices that are not geometrically coincident

- Connectivity associations are defined between two point features
  - Connectivity rules define what can be connected
Containment Associations

• Containment associations are used to model associations representing items which are containers and items which are content
  • Examples
    • a valve inside a pump station, or transformer inside a substation
• Only structures and assemblies can be containers
  • Devices cannot be containers, only content
  • Structures may be content (or both)
• Containment associations are supported with point, line and polygon features
Structural Attachments

- Structural attachment associations are used to model associations between devices and above ground structures where the device is “attached” to the structure; e.g., a transformer to a power pole.

- Simplifies reporting all structures associated with a subnetwork.

- Structural attachment rules are defined at the asset type level.
  - A structure can only support attachments or containment; it cannot support both.
Terminals - Overview

• A terminal represents a connection point on a device

• Terminals allow realistic modeling of devices
  • Important for CIM and sophisticated analytics without data extraction

• Terminal configurations and assignment are defined for specific devices
  • Devices that require a high and low side for analytic purposes (transformers)
  • Devices that require valences larger than two
  • Devices which control the flow of a commodity (valves, switches)
Terminals - Overview

• Creating a terminal configuration
  - Requires a name
  - Directionality
  - Number of terminal and names
  - Specification of which terminal is “upstream”
  - Valid configurations
  - Default configuration
Terminals – Use Cases

• City of Geneva, Switzerland  
  - Switch may either be connected to the bus bar on the left or the bus bar on the right or neither…  
  - Three terminals  
  - Three *valid Configurations*

- Left Bus bar
- None
- Right Bus bar

Diagram:
- Switch
- Connection Point
- Underground Line
- Bus Bar
- Connectivity Association
- Switch Junction Box
Terminals – Use Cases

• Valve – 4-way ‘L’ port side entry
  • Used to control the flow between two of four input pipes
    - Four terminals
    - Four valid configurations
      - Position A (Line 1 – Line 2)
      - Position B (Line 2 – Line 3)
      - Position C (Line 3 – Line 4)
      - Position D (Line 1 – Line 4)
Network Diagrams

- Integrated directly with the *Utility Network*
- Capabilities can be expanded to create simplified/enriched diagrams
- Collection of layout algorithms provided to lay out diagrams content
- Diagram owners control access rights
- Partners can extend with custom layout routines
Additional platform benefits
Services

• Extensions to existing services
  - Feature Service

• New services
  - Utility Network Analysis Service
    - (validate, trace, update subnetworks, export)
  - Network Diagram Service
    - (all things diagram)
  - Version Management Service
    - (version creation, reconcile/post)
Attribute Rules

• Configurable *Attribute Rules* will be exposed for the purpose of automatically populating field values for features
  • e.g., `[fieldA] = [fieldB] + "::" + [fieldC]

• Cross platform scripting language ensures updates applied regardless of where edits performed (desktop, mobile, web)

*Attribute Rules*
• Are applied when a feature is *Created, Updated, or Deleted*
• Are associated with a class on a subtype/domain (Asset Group/Asset type)
• May not modify system-maintained fields
Transaction Model

• Web GIS versioning model…
  - User experience same as with current versioning model

• Three primary workflows will be supported
  • Short transactions connected to the Feature Service
  • Feature services with sync for offline editing (ArcGIS Pro or Runtime based apps)
  • Long transactions connected through Feature and versioning services

• Benefits of new versioning model
  • No requirement to reconcile/compress nightly
  • Performance – well performing and scalable database queries
  • Temporal properties – history capabilities built-in, parallel posting, and support for partial posting
Transaction Model - User Experience

• ArcGIS Pro user experience working with branched versioning data sources will be identical to our current user experience with versioning.

• End user perspective - no new terminology is being introduced, allowing the user experience to be consistent within our applications and the underlying transactional model being completely transparent.
  - We are providing an alternate, improved implementation under the covers.
  - Change tracking, branch, refresh, and merge are internal terms.
Feature Templates – Group Templates

• Create multiple features with a single sketch
  - Examples
    - Pole at each vertex along an electrical line
    - Valves and end caps at designated locations along gas mains

• Options depend on primary template
  - Polygon – add other polygons, lines, and points
  - Line – add other lines and points
  - Point – add other points (can use line sketch)

• Add vertices or split lines as appropriate when other lines and points intersect

• Store generic group templates for known patterns with different template sets
Feature Templates – Preset Templates

• Create multiple features with a single mouse click

• Template based using a saved configuration of features
  - Includes attribute values
  - Includes all defined associations

• Use selection anchor during creation to identify feature to snap
Demo: Pro Editing Experience
How do I load my data into a utility network?
Loading Data Into a *Utility Network*

1. Prepare data
2. Data mapping
3. Create staging database
4. Load data into staging database
5. Post process data
6. Load data into Utility Network
Loading Data Into a *Utility Network*

- Requirements
  - Feature classes must have Global ID attribute
  - Relationship classes primary/foreign keys must be based on Global ID attribute
  - Data consistency checks
Loading Data Into a Utility Network

- **Requirements**
  - Source feature classes to utility network feature classes
  - Source feature class and subtypes to *utility network* feature class, Asset group, and Asset type (identify additional Asset groups and Asset types to add)
  - Source fields to utility network fields (identify additional fields to add)
  - Source domains to utility network domains (identify additional domains to add)
Loading Data Into a *Utility Network*

- Create a File Geodatabase and make use of data mapping
  - Import *utility network* feature class schemas
  - Add additional Asset groups and Asset types
  - Add additional attribute fields
  - Add additional attribute domains
Loading Data Into a *Utility Network*

- Load the source data from the *Geometric Network* into the staging database
  - Use the Geoprocessing Append tool
Loading Data Into a *Utility Network*

- **Generate additional features and association files**
  - Create connection points and any other features required for connectivity, containment, or structural attachments
  - Use relationship information to generate containment and structural attachment association files
- **Modify data based on devices with terminals**
- **Optionally:** Create additional features per model (e.g., fuses at transformers)
Loading Data Into a *Utility Network*

- Load data from staging database to your *utility network*
  - Use Geoprocessing Append tool for loading data from “stage” to production
  - Use Geoprocessing tools to import all association files
  - Enable Network topology
Assistance With Loading Data Into a Utility Network

• Esri working on white paper to outline the process
• Several partners have been working with Esri along the way and our group is ready to help (as is Esri Professional Services group)
• Esri provide tools:
  - Prepare Data – Data Reviewer
  - Data Mapping – Data Assistant tool
  - Create Staging Database – Data Assistant tool
  - Load Data Into Staging Database – Geoprocessing Append tool
  - Post Process Data – Esri working on scripts to automate steps
  - Load Data Into Utility Network – Geoprocessing Append tool
What Will Be Your Experience When Loading Data?

- Biggest question to ask yourself – What am I trying to accomplish in going to the utility network?
- What capabilities of network management are important to your organizations today and tomorrow?
- How would you model this?
What Will Be Your Experience When Loading Data?

- Which data representation is right for you?

Similar to existing data
Connectivity based on coincidence
Relationships join feature to structures

Do you want to here?

Or here?

Similar to CIM and your other external systems
Five terminal transformers
Model every connection
Questions?
Network Management – Growing the Platform

**Device**
- View, Query
- Simple Design/Inspections
- Tracing

**Desktop**
- Design, Maintenance
- Analysis, Modeling
- Map Authoring

**Portal**
- Utility Network Transaction Model
- Editing Tools
- Attribute Rules

**Web**
- Simple Editing, QA/QC
- Tracing
- Executive Dashboards

**Server**
- Online Content and Services
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