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# Utility Telecom Planning Framework and Reference Guide

2018 TECHNICAL REPORT

# Utility Telecom Planning Framework and Reference Guide

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# ABSTRACT


Telecom Planning is defined as an organization and set of operational functions that are responsible for the reliable operation of a utility's communications systems. This includes a clear System & Network Planning function, as well as a defined set of Standards of Operation. It also includes the management of a detailed set of Utility Standards and the evolution of current standards that define and manage the overall expectation for steady state network operations. A well defined Telecom Operations Process and Telecom Operations Center manages the continuous, reliable operation of the system. The Utility Communications system is quickly evolving to become the 3rd Grid, and should be organized, operated, and managed with that perspective in mind.

The purpose of this document is to help utilities both define and mature their Telecom Planning organization and process. It is not intended as a step-by-step procedure, but a guide to help structure an organization, and also to identify the internal capabilities and competencies needed to help ensure a reliable communications system. This document tends to be more Distribution and FAN centric since that is currently the area with the most change due to grid modernization initiatives. The principles however, extend to other communications types, including microwave radio and fiber optic commonly used to connect electrical transmission system facilities such as generation stations, switching stations, and control centers, as well as core enterprise facilities such as data centers, administration buildings, and service centers.

A conceptual process was developed to help utilities shape and evolve a Telecom Planning Organization. The process was broken down into key areas and related with an overall flow diagram. Each section was discussed in detail. The report also discusses the implementation of a long-term Telecom strategy with a focus on both organizational and process needs. Finally, it highlights industry practices and provides examples of the Telecom history, practices and challenges of a few utilities.



### Keywords

Telecom planning
Telecom operations
Grid modernization
Testing and simulation
Telecom organizational structures

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## Product Title: Utility Telecom Planning Framework and Reference Guide

**PRIMARY AUDIENCE:** Utility Executives and Leaders focused on establishing and evolving Telecom disciplines within the utility.

**SECONDARY AUDIENCE:** Utility Operational staff for Telecom Operations, Engineering, and Distribution Operations.

### KEY RESEARCH QUESTION

The purpose of this document is to help a utility both define and mature their Telecom Planning organization and process. It is not intended as a step-by-step procedure, but as a guide to help structure an organization and also to identify the internal capabilities and competencies needed to help ensure a reliable communications system.

### RESEARCH OVERVIEW

A conceptual process was developed to help utilities shape and evolve a Telecom Planning Organization. The process was broken down into key areas and related with an overall flow diagram. Each section was discussed in detail. The implementation of a long-term telecom strategy with a focus on both organizational and process needs was also discussed. Finally, it highlights industry practices and provides examples of the telecom history, practices, and challenges of a few utilities.

### KEY FINDINGS

- There is no one best set of practices for telecom planning. Each utility will have to own, embrace, and develop their own plan suited towards their particular needs, history, and culture.
- A strong executive sponsor is key to defining, evolving, and implementing an effective Telecom Planning Organization.
- The need for near real-time situational awareness due to increasing DERs is one of the key drivers for the evolution of Telecom Planning.

### WHY THIS MATTERS

Telecom Planning is defined as an organization and set of operational functions that are responsible for the reliable operation of the utility Communications System. This includes a clear System & Network Planning function, as well as a defined set of Standards of Operation, including Traffic Engineering and baselining of performance such that RF coverage, capacity, latency, reliability, and other performance metrics are always known and monitored. It also includes the management of a detailed set of Utility Standards and the evolution of current standards that define and manage the overall expectation for steady state network operations. A well-defined Telecom Operations Process and Telecom Operations Center manage the continuous, reliable operation of the system. Simulation and testing facilities allow assessment of possible changes to the system as part of the Change Approval Process. Finally, an Issue Resolution Process provides clear ways in which to manage conflicting priorities and avoid overly saturating the system or otherwise making changes that degrade performance below defined performance standards. Such a discipline must be instantiated as a comprehensive organizational capability tightly integrated with all aspects of planning for the utility’s electrical systems. The resources, facilities, tools, operational business processes and workflows should be clearly defined, structured and staged to be gracefully integrated over time as grid modernization needs expand. The utility Communications System is quickly evolving to become the 3rd Grid and should be organized, operated, and managed with that perspective in mind.

## HOW TO APPLY RESULTS

This information should help utility telecom departments evaluate areas for improvement by comparing their current organizational structures and practices against the example case studies and the comprehensive telecom planning process explained in this report.

## LEARNING AND ENGAGEMENT OPPORTUNITIES

- Member utilities have an opportunity to participate in continued collaborative research on this topic in the ICT Program under Project Set 161G, Telecommunications.

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**PROGRAM:** Information and Communication Technology, Program 161



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# 2
# PURPOSE AND SCOPE

The purpose of this document is to help utilities mature their Telecom Planning organization and process. It is not intended as a step-by-step procedure, but a guide to help structure an organization and also to identify the internal capabilities and competencies needed to help ensure a reliable communications system. This document tends to be more Distribution and FAN centric since that is the area with the most change presently due to grid modernization initiatives. The principles however, extend to other communications types, including microwave radio and fiber optic commonly used to connect Electrical Transmission System facilities such as generation stations, switching stations, and control centers, as well as core enterprise facilities such as data centers, administration buildings, and service centers. The document takes a more conceptual approach providing a segmentation of functions. Every utility will be unique with how they build their Telecom Planning Organization.

# 3
# THE TELECOM PLANNING PROCESS

The Telecom Planning Process is comprised of six major sub processes:

- A System Planning Process
- A Standards of Operations Process
- A Telecom Operations Process
- A Simulations capability
- A Lab & Field Testing set of capabilities
- An Issue Resolution Process

Together they create a comprehensive Telecom Planning Process. Figure 3-1 illustrates the relationship and dependent flows between each process. This section will discuss in detail the functions and flow for each sub process.

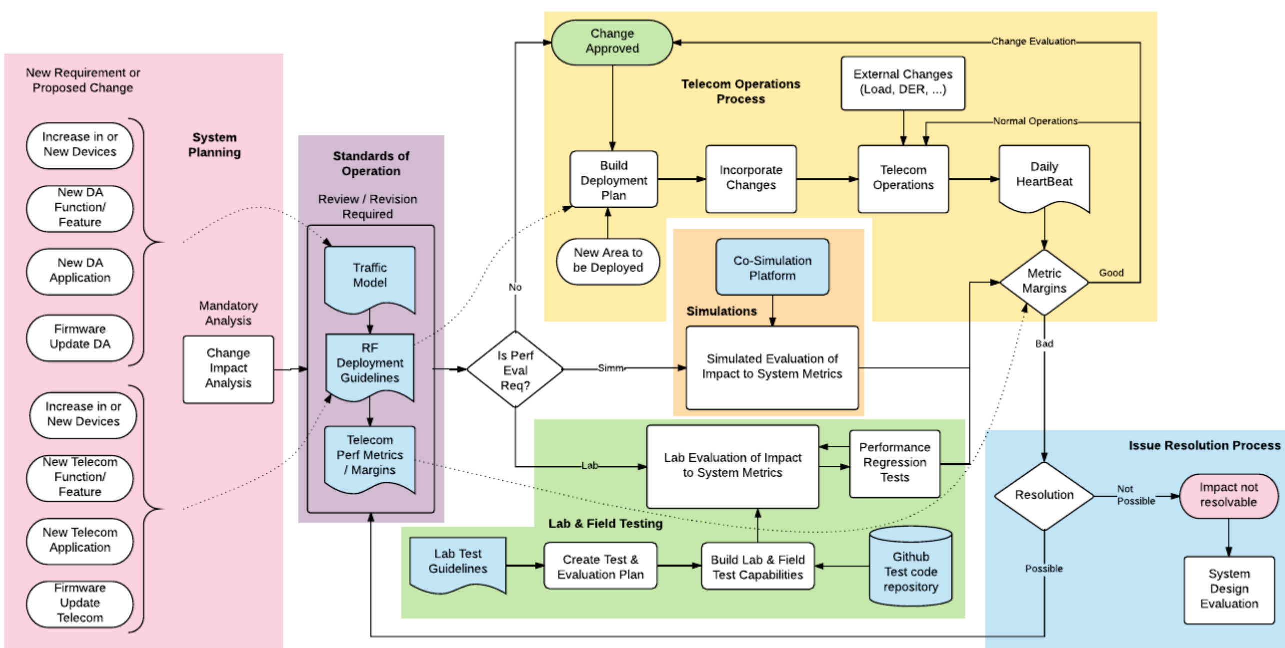


**Figure 3-1**
**Telecom Planning High Level Flow Diagram**

## 3.1 System Planning

System Planning is the process of mapping and planning any changes to the communication system that could affect its performance and ability to meet application SLAs.

This includes changes to the Distribution System as well as to the Communication System. Any planned changes to device firmware, application code, device numbers, or new devices should be evaluated to assess if there is a potential impact to the performance of the overall system. It is extremely important that the communications system roadmap and execution plan is tightly coupled with Electric System Planning. Ideally, a long-term roadmap looking out 3-5 years can be continually updated as a process. Near term detail should be much greater, highlighting feature improvements and firmware upgrades along with new device additions. Such a tool will allow Telecom Operations to assess, plan, and evolve the communication system to best support application needs. The roadmap is the key to being able to analyze and plan for the impact of changes to the system such that any necessary infrastructure changes or modifications can be completed in a timely fashion. The overall goal is to not be surprised when a new set of devices is added to the system and as a result degrades the performance of other critical applications.

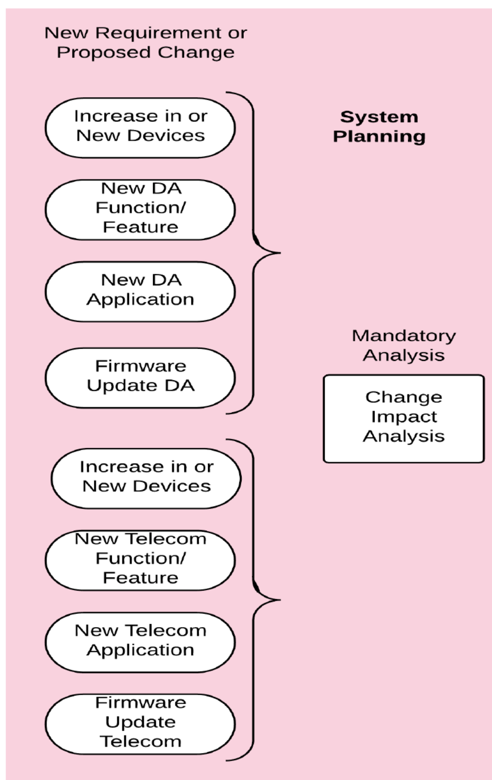


**Figure 3-2**
**System Planning Elements**

### *3.1.1 Distribution Planning Coordination*

The key point in coordination with Distribution Planning is to always be aware of any planned changes to the Distribution System that would impact the performance of the Communications System. Planning should ensure enough time to either:

- Make changes to the Communication System necessary to meet operational needs or
- Be able to inform Distribution Operations that specific changes are not possible without significant changes to the system.

In some cases, new functions may dictate the need for additional infrastructure or even a higher performance Communication System.

#### 3.1.1.1 Increase or New Distribution Automation (DA) Devices

New DA devices will cause increases in traffic flows. At some point, the ability of the Communications System to continue to meet Service Level Agreements (SLAs) will be challenged. Awareness of planned increases in devices allows communications to revise traffic planning and network infrastructure to best meet distribution needs.

#### 3.1.1.2 New DA Functions/Features

New features or configuration changes such as polling rates or algorithm latency needs will add additional traffic to the Communications System.

#### 3.1.1.3 New DA Applications

New applications using current devices will also add traffic and must be assessed as to their impact on the communications traffic model and system performance.

#### 3.1.1.4 DA Firmware Updates

Any firmware updates to devices should be regressed against know performance curves in the lab and/or a controlled field test environment to determine if there are any impacts to the communication traffic of the device.

### *3.1.2 Telecom System Plan*

In response to distribution needs, the Telecom System will need to increase its capacity and coverage. Changes in the environment from buildings, foliage, and communities will also create unforeseen interference resulting in operational challenges around capacity, coverage, and performance. It is not possible to measure or identify all of these impacts in the field. Instead, a robust operational process to monitor performance metrics and identify negative trends in Key Performance Indicators (KPIs) needs to be incorporated into operational practices to identify and mitigate environmental changes that happen outside utility control. All of these modifiers to the performance of the system need to be addressed as part of the system planning process.

#### 3.1.2.1 Increase or New Telecom Devices

New infrastructure or increases to the Telecom System should increase overall capacity and margins of performance.

#### 3.1.2.2 New Telecom Functions/Features

New features and functions should also increase overall capacity and margins of performance. It is important to perform regression tests against known performance curves in the lab and/or a controlled field test environment to determine if there are any unexpected impacts to the performance of the system.

#### 3.1.2.3 New Telecom Applications

Any new applications or network management improvements should also be regression tested against known performance curves in the lab and/or a controlled field test environment to determine if there are any unexpected impacts to the performance of the system. Management traffic can be a significant burden/challenge across low speed wireless networks and should be carefully monitored as new applications are added.

#### 3.1.2.4 Telecom Firmware Updates

Any firmware updates to devices should be regression tested against known performance curves in the lab and/or a controlled field test environment to determine if there are any impacts to the communication traffic of the device.

## 3.2 Telecom Standards of Operation

The Telecom Standards of Operations are sets of documents, data sets, and artifacts that define a stable point of operations for the Telecom System. These artifacts are an output of the System Planning Process.

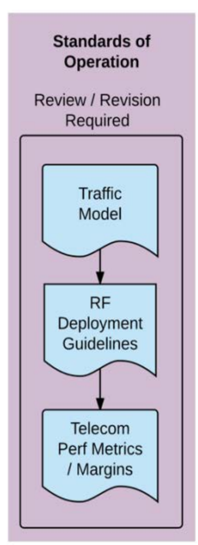


**Figure 3-3**
**Telecom Plannng Standards and Guidelines**

A specific number of devices and applications define a Traffic Model that identifies the capacity and latency required within the network to meet performance SLAs under various conditions. The Traffic Model is a set of requirements used as an input into the Deployment Guidelines. Traffic Models are developed for various scenarios (e.g. Blue Sky, Emergency Scenarios, Outage Scenarios) to determine guidelines for deployment, operations, and capacity planning. A set of margins can be defined, given a specific Traffic Model and a specific deployed network, resulting in a set of metrics that are measured during the normal daily operations of the system.

These processes and procedures for modification approvals should be managed by a Telecom Standards Review Board.

### *3.2.1 Communication Traffic Model*

The Communications Traffic Model is a tool that can be used to model traffic flows and capacity needs for the communications system based on grid topology, applications, and day of conditions. The goal of the model is to accurately represent the aggregate application needs from the overall system at defined points and under specific use scenarios. One approach is to model the amount of capacity that is needed by the applications, and not the actual capacity that is provided by the network. Section 3.2.1 discusses how the Traffic Model can be used as an input to the Simulation Tool to estimate how the network will perform under the defined load. The Traffic Model can also be used as discussed in section 3.2.3 to generate load for the Lab Test Environment. In addition, the model defines monitoring metrics for day-to-day operations, and planning metrics for long-term growth and procurement of the communications system. Figure 3-4 depicts how these components can be used to model aggregate peak and average capacity in the network.

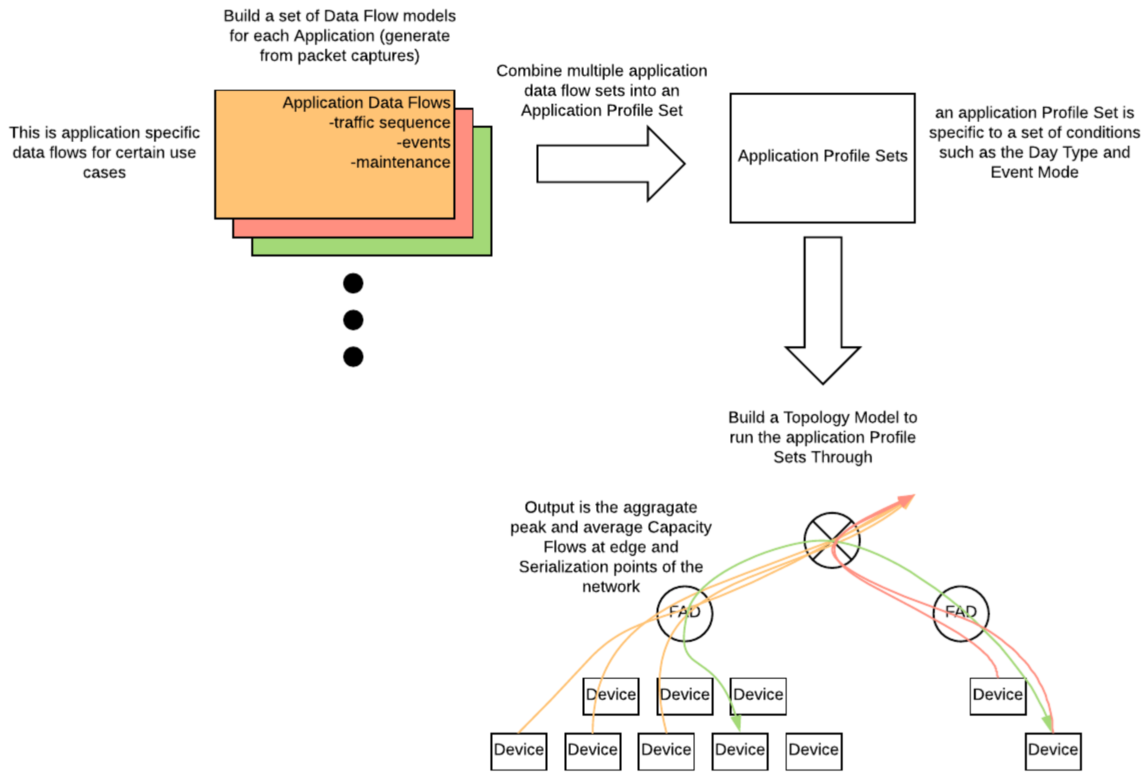


**Figure 3-4**
**Communication Traffic Model Flow Diagram**

### 3.2.1.1 Application Data Flow Models

Each application that is run over the Communications System has a finite set of traffic sequences that can be defined and modeled. This includes a number of packets of a specified size and type sent in a specific sequence from a device. There may be multiple sequences for each application called Application Traffic Sequence Events (ATSE). Packet captures from the Distribution Management System and Field Devices can be used as a basis to build ATSEs.

### 3.2.1.2 Day Types & Event Modes

Any number of Day Types or Event Modes can be defined. Day Types are repeatable days or periods of days (e.g. morning, night) with common operational application behaviors such as a weekday, weekend, or holiday. Event types are specific events that may happen on a common Day Type or over a period of Day Types, such as Blue Sky conditions, Storm Conditions, Overcast, or a Disaster Event such as a Fire, Flood, or Earthquake. Identifying a set of Event Modes provides a basis to assess the needed capacity of the communications network under adverse conditions.

#### 3.2.1.3 Application Profile Sets

An Application Profile Set can be defined for a type of day (e.g. weekday, weekend, holiday, …) paired with an Event Mode (e.g. Blue Sky, Storm, Disaster, …). A list of ATSEs at specified times or intervals (may be randomized) can then be used to create a Daily Application Profile Set (DAPS).

#### 3.2.1.4 Traffic Model Topology

The number and type of devices, as well as the applications run on the distribution system will vary based on the network location in the system. It is often not practical to try and model the traffic flows for the entire system. Instead, it is easier to define a limited set of topologies for the distribution system that are representative of a utility's infrastructure. It is also not necessary to understand the specific network paths, only the hierarchy of devices. This allows the traffic to be modeled from a "Core to Edge" or a "Peer to Peer" perspective without having to worry about the exact path or number of devices in the path. In this way the Traffic Model can be used to identify the needed throughput at specific points in the network based on the application needs at those locations. The needed values can then be compared to saturated capacity curves and operating margins.

### *3.2.2 RF Deployment Guidelines*

The performance of a Distribution FAN is highly varied and dependent on many factors such as traffic, location, deployment model, interference, and vendor specific implementation. There is also variability in the methods and metrics that can be used to plan, evaluate, and test such a system to accurately compare performance across multiple architectural choices and vendors. The Traffic Model discussed in the previous section can be used to identify the amount of capacity needed and where in the network. Through the use of lab testing, field testing, and simulations, the amount of capacity and performance for a specific density of devices can be defined for a specific topology (terrain morphology, clutter, interference). By combining locational Traffic Modeling values with lab and field testing results, a guide for how to best deploy the RF network in order to meet the needed capacity and performance can be created. This RF deployment guideline would include items such as:

- Average device density for desired performance given morphology type
- Installation guidelines for pole, padmount, underground, transmission tower, and other infrastructure
- Sector acceptance criteria, process, and guidelines
- Guidelines on antennae, sectorization, core network connectivity
- Guidelines on RF network redundancy and reliability
- Deployment strategy options (e.g. canopy first, incremental, coverage first, then scale capacity)
- Deployment strategy tuning optimization process based on field testing and then on learnings from initial area deployments

### *3.2.3 Telecom Performance Metrics*

A set of performance metrics should be established that are monitored and trended on a daily basis to track peak and average values. Margins of operation should also be established such that if a margin is exceeded or if a trend projects that margins will be exceeded in the near future, plans can be taken to mitigate the effects on the system. Margins can be determined for a specific technology and deployment model. From lab measurements an optimal capacity point of operation can be determined as there is typically a tradeoff between peak capacity and latency (e.g. the more lightly loaded a network, the better the average latency). From the Traffic Model, a required capacity can be determined. From these values a desired margin can then be determined based on the criticality of the applications running on the network. Typically, a 20 to 30% margin should allow time to mitigate system issues through increased infrastructure. At a minimum these metrics should be measured at key serialization points in the network.

## 3.3 Telecom Operations Process

The Telecom Operations Process encompasses the procedures that facilitate the daily operations to the Telecom System. It is more complex than the below diagram. The basic concepts depicted are valid, and each utility will have its own specific process flows that are matched to its service territory, systems, and applications.

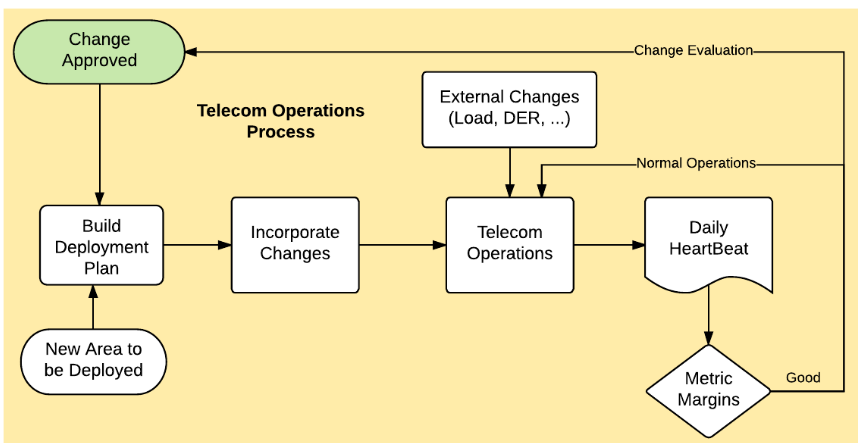


**Figure 3-5**
**High Level Telecom Operations Process Flow**

In general, there is a day-to-day operations loop where the system is monitored. Here, a "Daily Heartbeat" of performance metrics is measured against the operational standards metrics for allowed margins. The trend over time of the metric margins should also be monitored. This allows the utility to plan for needed changes in the system to account for the trajectory of the trendlines. There are multiple mechanisms that can perturb the steady state of the systems and trigger changes to the Traffic Model, Deployment Guidelines, and Metric Standards. These include both planned changes to the systems, as well as unplanned external changes to the system.

### 3.3.1 Telecom Operations Center

The Telecom Operations Center is ideally a core facility and function that monitors and manages all communication systems for the utility. A centralized location with redundant backup is an ideal design with all functions managed and operated within a common organization structure. In many cases, the utility's communication management is still siloed across multiple organizations such as Metering, Distribution Telecom, Transmission Telecom, T&D, and IT. This document's section on Organizational Structure (Section 4.2) will further discuss ideas and best practices for recommended organizational structures. In terms of a facility, the idea of a big open space with large expanses of screens as status monitoring of traffic flows similar to a state of the art Energy Control Center, should be the long-term goal for utilities. Ideally, Power and Communications Operations Centers can share the same screen overlays and have an integrated fault status awareness.

#### 3.3.1.1 Daily Heartbeat

A complex set of metrics should be measured and monitored across relevant time intervals and reported as a hierarchical set of status for the Communication System. There is undoubtedly a very large set of possible metrics to choose from and some should be related to critical application performance. Some general metrics that should be measured are listed below:

- Availability of nodes
  - What percentage of time is the node reachable and over a defined period what percentage of all the network nodes are available? This metric can be monitored by a low duty cycle ping or by periodically pulling network traffic metrics.
- Reliability of available nodes
  - How often does a reachable node meet the performance requirements of the system? This can be extracted from ping timing or from periodically pulling operational metrics. It should be noted that performance is not necessarily symmetric on networks and in many cases latency and throughput can be different for uplink and downlink and therefore should be tracked and recorded separately.
- Latency
- Throughput
- Serialization point capacity margin
  - In mesh systems or in star systems the aggregation point is usually the serialization point of the network (the point of the most constrained traffic which will most likely be the point at which network throughput is limited).
  - The maximum capacity should be determined in a lab environment. A traffic sniffer or metrics extracted from the devices or the NMS can then be used to continuously calculate, plot, and trend the available margin at the critical points in the network.
- Memory and CPU usage statistics

#### 3.3.1.2 Metrics Regression Cycle

Establishing a set of metrics for the overall network not only gives a current view of the system but also should monitor margins of performance and help to identify issues such as capacity constrained points or increasing signal attenuation due to foliage before such issues become critical. This allows a proactive performance mitigation planning cycle to help stay ahead of changes to the system.

### *3.3.2 Deployment Planning*

A Deployment Plan that incorporates both changes to the operational devices using the Telecom System as well as new and or improved Telecom System devices is the basis for the measured evolution of telecom operating practices and metrics. A timeline of all changes and a plan to change operational metrics accordingly should be managed on a periodic interval that is appropriate for the complexity and rate of changes being made. For example, over a period of time (months) both new RFIs (Remote Fault Indicators) and Switches are being deployed in increased numbers as well as requiring an increase in telemetry capacity and control latency. The new systems went through the System Planning, Testing, and Simulation process so the required system performance at locations in the network is known. Prior to deployment of the new DA devices, increases in the Telecom infrastructure are planned. Once deployed, the operational metrics can be increased such that the DA devices can be deployed and perform to specifications. A master deployment plan for telecom with dependencies linked to operational systems will allow for proactive management and greatly help avoid the need for reactionary system changes.

### *3.3.3 Change Approval Process*

Any changes to the system whether due to planned deployments, new applications, features, or services must go through a change approval process. Ideally, simulations and lab testing can perform a complete evaluation such that the impact of changes can be evaluated against the established performance metrics. In cases where this is not possible or even as a first phase of a new feature release, a single section or sector of the network would be deployed as a test area and evaluated against the operational metrics. Once the new change performance impact has been evaluated and deemed acceptable the changes can then be rolled fully into production.

#### 3.3.3.1 Planned Changes

All planned changes to the network should go through an evaluation impact analysis prior to deployment approval. These changes include but are not limited to:

- Firmware upgrades
- New applications or features
- New coverage areas
- New or added devices

#### 3.3.3.2 External Changes

There are many variables outside of the utility's control that can effect changes to the environment and systems connecting to the power grid. These changes can act to degrade the performance of the system, typically in localized instances.

- Foliage growth and incursion
- New construction causing signal shadowing
- New behaviors, traffic flows, parking routines, that can shadow systems or generate interference
- Growth of Consumer DERs
- Evolution of market models that drive telemetry from DERs to utility (3rd party vendor changes)
- Increase in electric vehicles and telemetry/control to utility as market models evolve

Proper monitoring of metrics can identify areas that will need improvements to infrastructure and capacity or identify the need for an added feature from the system vendor.

## 3.4 Simulations

A Simulations Toolset allows the utility to easily evaluate how planned changes to the overall system will impact the performance of the communications system.

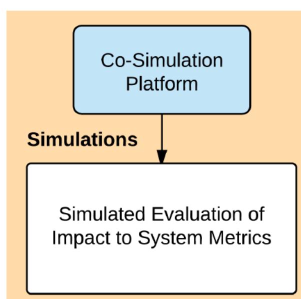


**Figure 3-6**
**Telecom Planning Simulations**

Such a tool can be developed over time. It is not necessary to model the entire system, such a task would be too complex and is not practical. It is only required to model the areas of the system that drive critical operational applications and do so under specific operating scenarios. More specific areas can be added as the toolset evolves to help with all aspects of operations, deployment, and planning.

### *3.4.1 Grid Co-Simulation Tool*

There are many possible tools but as yet there is no off the shelf turnkey tool available. This is partially because every utility is unique in its topology, service territory, and sets of applications and systems. It is also partially due to the fact that, prior to grid modernization, such a toolset has not been critical to operations. As the reliability of the distribution system becomes more and more dependent on the Communications System, such a tool will be required. EPRI is working to develop a set of open-source tools into an event based, co-simulation platform that will enable simultaneous modeling of the power grid, connected devices, and their communication links. An example use case would be to model the distribution grid in a specific area, and then add a "future state" of, for example, 50% higher DER. Within the model, it becomes possible to vary parameters such as:

- The number of connected devices.
- The Traffic Model Generated Capacities for different scenarios
- The available bandwidth and serialization point(s) for the communication network.
- The type of wireless technology used for communications.
- The effects of impairments or damage to either the power grid, the communication network, or both.

The model should support protocol definition, layered interfaces, channel modeling inputs, power path models, varied traffic loading models for communications and power flow models for the energy path as well as being able to run ranged, event based, simulations. Such a platform will also be useful to model expansion of the grid in both new geographic areas as well as increasing the density of deployed communicating devices.

## 3.5 Lab & Field Testing

Lab and field testing capabilities are yet another key set of tools needed to maintain and manage a reliable grid. It is critical for utilities to be able to accurately evaluate the performance of a communication system both before procurement and before new firmware, functions, and applications are rolled into production. The cost of discovering a performance issue after deployment can be orders of magnitude more impacting than pre contract or roll out. At worst it may be discovered that the system you procured or the application feature you intend to use cannot be realized on the current system. At best, failed pre-deployment evaluations will require a roll back of functionality and may adversely impact reliability.

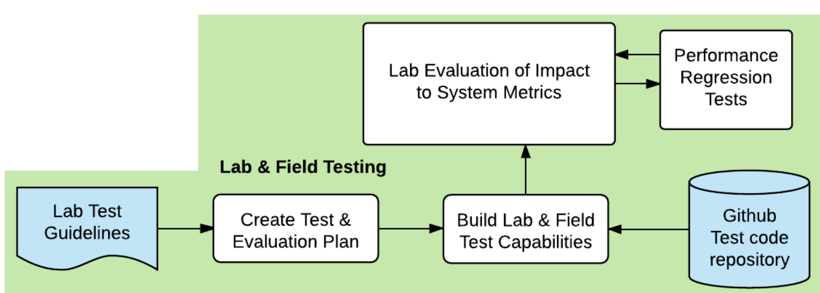


**Figure 3-7**
**Telecom Planning High Level Lab & Field Testing Flow**

There are many reasons why it is imperative to test and not assume a system will meet the advertised levels of performance. It is quite typical for many systems both for distribution control equipment as well as edge DER devices to specify that they can perform at high rates of information exchange. The fine print will say that this assumes a communication system that can also meet these requirements. Many vendors will test with ethernet or a wideband wireless system. More realistically, there is no great solution for utility Field Area Networks and even consumer and campus networks that might connect DERs can be slow or heavily loaded or both, impacting the overall performance of a system. If you cannot measure the performance of the communication system, you cannot characterize the actual performance that will be realized in real deployments. There are many points to this topic.

- No network is completely isolated, there is always other traffic and in practice most all communication networks are shared across multiple applications. Systems should be tested under such conditions. At some point they will degrade in performance. Knowing this point by having the ability to measure the communication system's actual performance lets you understand the root cause of degradation.
- In the absence of visibility into the actual comms performance, you are only guessing at the root cause of an issue. Is it a bandwidth issue, is QoS performing properly, is it a routing problem? An MTU issue? An interference issue? Networks are highly complex and there are many layers that can affect performance.
- A communications testing framework also allows you to understand your test setup. Am I really getting what I think I should be getting? It is very easy to have a poorly performing network and not know it or be able to quantify it. A typical example would be testing only for functionality of a specific application in a lab and not understanding how the system performs under load or in the presence of interference. Metro wifi was a classic example of large sums of money invested based on unloaded performance demonstrations only to find that once the system was deployed, loaded performance could not support the needed capacity of the targeted users and applications.

In general, if you can not characterize the communications system you can not understand if a performance degradation is due to the grid control system or the DER system or if it is caused by a communications issue. Without that level of visibility you are in a position where you can't quantify the root cause of an issue which in turn makes it very difficult to resolve.

### *3.5.1 Test Plan*

A test plan that defines the testing environments, setup, and test cases should be created as a basis for both technology selection and continued regression testing. A template for a detailed test plan with technology variations is beyond the scope of this document. Such a document will vary depending on the technology being tested but could include but not be limited to:

- Test plan scope and purpose
- Test environment setup and required equipment lists
- Physical Layer Performance Testing covering sensitivity, frequency accuracy, interference susceptibility
- Network Layer Performance Testing covering latency, throughput, CoS, aggregate capacity

- Security
- Network Management System functionality
- Routing both peer to peer and edge to core, IPv4, IPv6
- Protocols such as Multicast, Anycast, Broadcast
- Protocols such as DNP3, 61850, serial to packet support
- Embedded Compute functionality
- Scenario testing of specific use cases such as switching schemes, aggregate telemetry, failure cases, firmware update, and many more

### 3.5.2 Testing Platforms

There are many ways to develop a Communications Testing Platform and as with a Co-Simulation platform there is no simple turnkey solution that can be purchased. Every utility is unique in its specific footprint of technologies, applications, deployment needs and processes. Each utility will need to build its own set of core functionality to support what is needed to maintain grid reliability. Automation of testing, storing data, and post processing of the results is needed in order to sufficiently test and maintain modern utility Communication Systems. The complexity of the currently available technology, the increased performance requirements, and the need for ongoing regression testing mandate a well managed and automated test regime.

EPRI has been working to evolve and consolidate automated tools that multiple utilities have developed based on a set of open source repositories and methods. The EPRI Fan Test Platform is a python-based testing suite designed to comprehensively evaluate the performance of communication systems focused specifically on Grid Modernized Distribution Automation needs. A Lab Communications Test System Design is used in conjunction with a set of Lab Guidelines to configure test scripts to specifically match Lab and Field test setups.

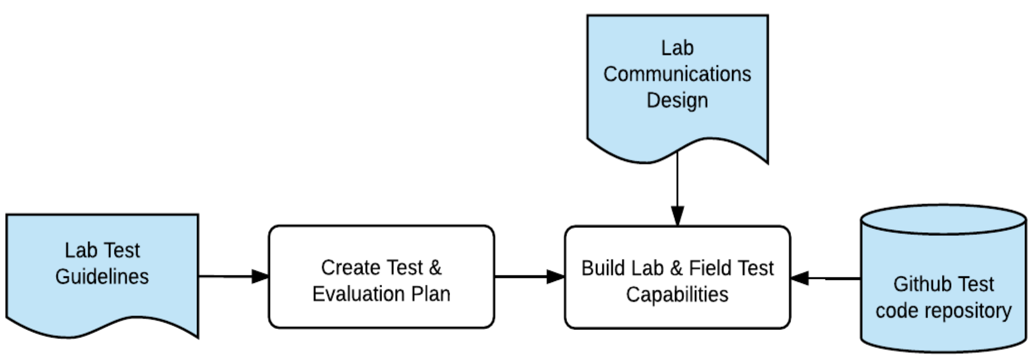


**Figure 3-8**
**Testing Platfrom Flow Diagram**

A private git repository is setup to manage revision control, lab specific configurations and tests. A testing framework is used to fully automate testing and data post processing allowing consistent, repeatable testing and results generation. The framework includes:

- A set of basic test structures for latency, throughput, capacity loading, QoS performance, and specific distribution use cases. The framework is extensible and new or lab specific tests can be added as needed.
- A set of configuration files that are specific to lab test environment, vendor technologies, and test run configurations.
- A set of post processing routines to automatically generate usable plots, graphs, and .csv files for analysis and comparison of performance metrics.

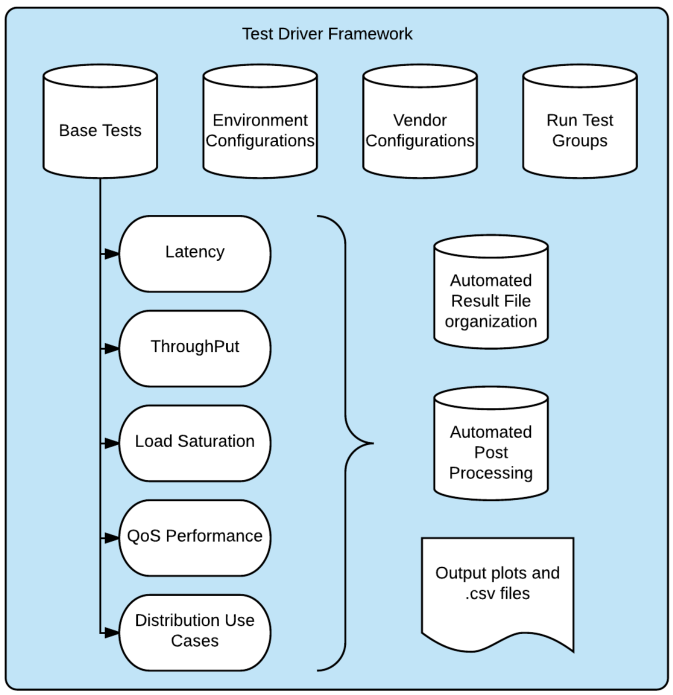


**Figure 3-9**
**Testing Framework Components**

A set of Lab Guidelines needed to build a test environment include:

- A Lab Network Design Diagram (needed with detail IP addressing, routers, servers, firewalls, etc. to properly design and configure codebase)
- An initial test plan(s) (needed to configure and customize test to lab environment)
- Servers/Raspberry PIs/Virtual Machines (VMs) setup to support Lab Test Environment
- Utility Private Repository setup and configured for needed tests and technologies
- Customization to support a to be defined set of initial test cases (as defined in test plan doc)
- Post processing automation of all tests in test plan

- Expansion of all of the above items to support increasing lab capabilities over time (such as a RF performance wall and new lab network configurations).
- Documentation of code base including detailed comments inline
- GitHub Wiki to include
  - general overview of test code base, usage, and setup
  - repository usage guidelines and usage notes/FAQs
  - Test set up and running guidelines
  - Test examples
  - Post processing setup and running guidelines
  - Post processing examples and interpretation guidelines
- Workshops to train utility employees
- Web sessions as needed for training and support
- Recorded online training video walkthrough with voice overs of Github and Wiki

As part of the Telecom Initiative, EPRI has created a Testing Framework incorporating many of these items that can be adopted by interested utilities to get started with their own Testing Framework and Lab.

Presentations from an EPRI workshop on the testing platform were held August 1-2, 2017, and hosted by Southern California Edison at their Westminster, CA lab. Presentations from that workshop are available to EPRI Telecommunications Initiative member utilities through the Member Center, Collaboration web site.[1] The Github repository for the testing platform is currently available to Telecom Initiative and Project Set 161G members, with the plan to transition the repository to an open source project which then becomes publicly accessible.[2]

### *3.5.3 Performance Regression Test Cycle*

A Performance Regression Test Cycle is used to periodically re-test the system to ensure that the required performance metrics are still operating within the allowed margins. Firmware updates, new features, added traffic patterns or load, and new devices can all affect how the system performs. Any changes in the systems configuration should be run through repeatable, automated tests to track performance of the system.

[1] https://membercenter.epri.com/Collaboration/4000000941/Lists/EPRIDocuments/Workshops%20and%20Webcasts/2017_08_1-2_WirelessTestingWorkshop_3002011631

[2] https://github.com/epri-dev/EPRI-Field-Area-Network-Testing-Platform/wiki

## 3.6 Issue Resolution Process

Finally, a process needs to be developed to resolve issues when new devices, features, or modifications to the system cause the allowable communication system performance metric margins to be exceeded.

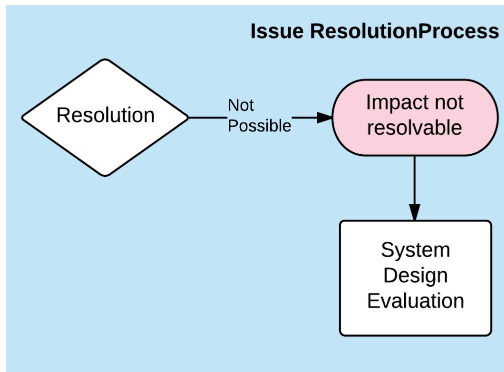


**Figure 3-10**
**Issue Resolution Process**

There are multiple factors that can cause system degradation. Some are internal and planned such as an increase in devices on the system or added applications or features. Others are internal and unplanned such as an applications algorithm adding capacity that was missed in the long-term planning efforts. Still others are external and are planned, such as aggregator DER growth, or unplanned, such as rapid consumer DER growth. A specific workflow for each of these types of system impact will need to be designed and tightly coupled with the change approval and internal standards modification process.

There are also many possible resolutions to system changes that impact performance metrics. It may simply be appropriate to modify the margins. In other cases new infrastructure may need to be deployed to add capacity in certain areas. Vendor feature or performance improvements may also help to resolve issues. It is also entirely possible that a desired application or device may not be able to be supported by the current communications system. In such a case an evolution to the system such as the addition of a higher capacity overlay may be necessary.

The overall goal of the issues process is to ensure that there is an evaluation of the impact of changes to the system prior to deployment in order to avoid unintentional degradation of current and critical applications. The ideas is to plan as much as possible and make informed decisions as to how to best manage the growing demands on the communication system. When the change is unplanned a clear process exists as to how to best manage and mitigate system impacts on the performance of the system.

# 4
# TELECOM PLANNING IMPLEMENTATION

The evolution, development, and maturation of a Telecom Planning function within a utility is far from a simple task. Such an effort spans multiple systems, organizations, and touches or will eventually touch nearly every device in the system. It is ultimately a long-term transformation that will take years with each utility implementing its own unique set of structures. This section will discuss some ideas on how to best migrate from a current state to a reasonably mature first implementation of a Telecom Planning set of capabilities. Components of a 15 Year Telecom Strategy, some thoughts on possible organizational structures and factors related to governance, a few of the most popular industry frameworks for helping a utility to define its Telecom Business Processes, and finally, a few examples from utilities that are currently in the process of modernizing their Telecom systems, organizations, and capabilities will be covered.

## 4.1 15 Year Telecom Strategy

A utility desiring to implement a set of Telecom Planning functions should develop a 15-year strategy to gracefully integrate Telecom Planning changes into existing organizations, processes, and standards. The 15-year strategy should include but not be limited to:

- A set of Communication System Requirements for the expected services and applications
- A High-Level Communication System of Systems diagram
- A map of the Serviceable Territory over time and expected geographical coverage needs
- A Coverage and Capacity Analysis over time mapped to the Serviceable Territory
- A Traffic Model as discussed in section 3.2.1
- A Communications System Concept of Operations Document
- A plan to build and support testing in the lab and in the field along with supporting simulations tools and capabilities.

### *4.1.1 Communication System Requirements*

The Communications System Requirements should include all of the major functional areas and critical performance parameters for the communication system. It is impossible to know exactly what will be needed over a 15-year time window but even so a set of architecturally significant use cases combined with current best practices can be used to generate the best possible set of requirements. A comprehensive set of requirements should include:

- Significant DA, critical DER and Distribution System Operator (DSO) type use cases as examples that set the performance requirements for the system

- Distil these requirements into a set of core (architecturally and cost significant) functions and business services needed to meet the requirements
- Cover Communications Performance, Routing, Security, Distributed Compute, Network Management and other key requirements
- Cover key back office systems requirements, including legacy support, needed integrations, and transition cases
- Provide a definition of the Serviceable Territory and device locations such that a detailed coverage model that provides an itemized list of equipment and deployment locations necessary to meet the system performance requirements can be generated

### 4.1.2 Business Value Traceability

Many factors contribute to the need for Grid Modernization. One of the most significant of these is the accelerated adoption of DER across the distribution networks, challenging the operational tenets used to plan, design, operate, and maintain the grid. It is beyond to scope of this paper to cover these impacts in detail but in general, as DER adoption grows, the number of possible control actions will increase while the time necessary to respond will decrease beyond what is manageable by human grid operators. It is important to map these business drivers to the advanced technologies necessary to maintain grid safety and reliability. A set of business value artifacts should include:

- Provide as many traces from system requirements to business requirements as is possible
- Map functions and business services to logical devices and equipment over a timeline suitable for creating a traceable cost model
- Process cost models related to new required business functions
- Value stream cost/benefit model for each core business function (e.g. AMI, IVVO, DA, etc.)
- Cover organizational change cases that impact business processes and the cost model

### 4.1.3 High Level Communication System of Systems Diagram

A detailed set of system of systems diagrams illustrating all components and major data paths should be created and maintained as the system evolves. These should include but are not limited to:

- High level one line diagrams illustrating high capacity core network connection points (e.g. fiber substations, comms sites) and field device types phased over time
- Alternate view of high level diagrams illustrating key points of interoperability with standards to be utilized
- Alternate views of high level diagram to illustrate existing and planned components – or use multiple views showing transition. Transitions indicate expenditures that need to be in the cost model.
- Show end to end connectivity including field, substation, and core networks
- Show layer dependencies across interfaces and locations

- Show high level security firewalls and segmentations across interfaces and locations
- Show distributed compute components and locations

### 4.1.4 Serviceable Territory

A definition of the Serviceable Territory is the basis for procurement, operations, and system performance analysis. It defines the area within a utility's overall territory that requires communication coverage. A good working model is to take a ¼ mile buffer around all distribution, transmission, and other assets to define this area. In many cases the Serviceable Territory is only 20% of the overall utility territory. As population grows and new assets are added this definition will evolve over time and should be maintained. This map provides a basis for coverage, capacity, and deployment planning. The Serviceable Territory definition should be maintained as part of the master GIS record and include the definition and map of the Serviceable Territory projected over time segmented by Grid Modernization System Requirements.

### 4.1.5 Coverage and Capacity Analysis

A high level coverage and capacity analysis of wireless systems across the serviceable territory should be developed and maintained in order to better estimate and plan infrastructure requirements for the Serviceable Territory. RF planning tools, Network Management System metrics, and Field Measurements can all be used to help generate coverage maps. A hierarchical, localized capacity plan should also be created and is discussed as part of 3.2.1 on Traffic Modeling. A combined Coverage and Capacity Analysis allow the estimation of the total devices needed to give baseline coverage of a defined Serviceable Territory and additional needs to meet capacity model requirements.

### 4.1.6 Traffic Model

The Traffic Model is an ongoing estimation of the amount of peak and average traffic requirement at specific locations in a communication system. These locations are typically at serialization points of the network where capacity is most constrained and based on actual application data flows under varied conditions. Section 3.2.1 discusses Traffic Modeling in greater detail. A projected traffic model based on applications, devices, and needs is the basis for estimating infrastructure requirements for capacity at scale.

### 4.1.7 Testing Capabilities

Testing capabilities, including labs, field testing, facilities, and teams to support testing are critical to both selecting technologies, as well as to long term stable operations of systems. A 15-year strategy should include plans and a budget to grow these capabilities over time.

- Simulation and modeling tools
- Lab test bed for technology evaluation and regression testing for new firmware, applications, and services to ensure that there is no impact to critical application prior to deployment or upgrade

- Field testing to validate simulations and lab testing
- Support the creation of detailed deployment guidelines, policies, and procedures

Section 3.2.2 covers these areas in greater detail.

#### *4.1.8 Communications System Concept of Operations Document*

A Concept of Operations Document is intended to broadly discuss and communicate all of the elements of the 15-year Telecom Strategy. It should provide a high level overview that discussed how all of these elements integrate to provide operational benefits, improved reliability, and greater customer satisfaction over time. This document is used to both communicate and align the overall strategy across various organizations as well as regulatory efforts. The document should include but is not limited to:

- The operational vision over time
- Operational guiding principles and key functional operating philosophies
- Linkage of operational elements to corporate business strategy and regulatory requirements
- Traceability and reference to evolving industry best practices (e.g. NIST/SGIP architecture, DOE/PNNL architecture, other utility architectures)
- Technology choice discussion and drivers (Commercial Cellular, Private Cellular, IOT, Mesh, ...)
- Discuss benefits of a common communication system that provides service to multiple systems (e.g. AMI & DA)
- Cover topics such as value for high levels of DER penetration, future DSO type market operations, distribution resiliency, the value of distributed compute
- High level discussion of end-to end architecture

### 4.2 Telecom Organization and Resources

As the Telecom needs of a utility become more and more complex, the organization will need to evolve as new systems and services are procured and deployed. Not only will new functions be required, but also new and more sophisticated technical skills, tools, and business processes. The resources and facilities needed must be identified and implemented as the business processes are transformed to support a long-term Telecom Strategy.

In many cases utilities have organizationally structured the teams required to maintain and operate communications systems around the applications using the system. Metering for AMI, Distribution Operations for DA Communications, Transmission Operations for their Comms systems, IT for LMR systems, and so forth. As communication systems migrate ultimately to all IPv6 networks, siloed ownership of systems will become more and more problematic leading to increasing inefficiencies and degraded reliability in systems. A utility should strive to integrate all communications teams into a common organization that is at an equal organizational peer to Distribution, Transmission, Customer Care, and other such organization units effectively treating the Communications System as the 3rd Grid. Ultimately, every device will be networked and, the number of communications devices will equal or exceed the number of grid control and monitoring devices. The criticality of the reliable operations of the communications systems will only increase. As such, the leadership for such a system must both have the requisite technical and operational experiences as well as be able to influence organizationally at the same level as any other critical peer organization mentioned above.

In discussions with several utilities it is clear that there is no one best organizational structure for Telecom. In fact, there is a large diversity of organizational models that have been made to work well. One clear theme that appeared to be common was the strong need for an executive level champion. There is also a general consensus that, historically, Telecom was originally organized around Transmission or Power Generation. As the number of applications, networks, and systems evolved within utilities and IT organizations emerged and grew, there was a migration of most Telecom over to IT. As Grid Modernization increases the criticality of the communications systems, we are now seeing Telecom either migrating back to an operations organization or remaining in IT but with stronger organizational focus and highly matrixed with operations. In all cases Telecom is clearly becoming more focused in its organizational responsibility, discipline, and executive sponsorship.

Another trend that we are seeing is more and more blurring of the term "IT" within both the industry in general as well as the utility industry. In some utilities the more traditional view of IT as an Enterprise organization focusing on data centers, PCs, email, and other service based applications holds true but in more and more instances these Enterprises services are being outsourced and IT is becoming a mix of Operations, Architecture, and Systems Engineering functions. What IT means can be very different depending on who and which utility you are talking to.

One of the challenges the "new" utility IT department faces is the need for skill sets that bridge both operational and communications engineering disciplines. These skills must either be hired or learned internally. Power Engineering and Communications Engineering experience and knowledge is required. Power Engineers and Communication Engineers both have a strong educational foundation in complex mathematics, physics, electro-magnetics, and analog signal propagation whether over the air or over power lines. In contrast, more application- and service-oriented IT engineering backgrounds have a more difficult challenge learning Power and Communications fundamentals as they need to go back and learn a whole new set of foundational engineering knowledge. In many cases we are seeing Power and Communication Engineers evolving and working across utility disciplines throughout their careers.

## 4.3 Existing Industry Processes

There are many tools and processes that can be adopted by a utility to help manage the overall Telecom Planning structure. There is also no one standard or process that provides an easy to follow, well defined, guide. Rather, there are many deep and complex standards that can be piecewise cobbled together to help a utility define its business process framework. As there are many choices for communications systems, there are also many possible structures and practices that can be implemented to manage the overall business processes associated with Telecom Planning. A detailed discussion of all of the possible tools and practices is well beyond the scope of this document. However, we will discuss an overall best set of practices and a recommended philosophy for such process implementation. Ultimately each utility will need to "own" their process and design it to meet their specific needs and structures.

Before we can discuss specific tools and standards for industry processes a framework for implementing changes in structures mapped to existing business functions needs to be established. At the highest level, any business process has three components, Direction, Change, and Operation. Direction does exactly what it states, it sets the direction for the company or organization encompassing the Governance and Strategy components of a business. This is typically an executive level set of functions. Change is the implementation of the strategy and new functions within an organization. The Architecture, Design and detailed Program Management of the projects to implement the changes are executed here. Once completed, new functions and capabilities move into an Operational steady state with incremental changes over time as needed or mapped by strategy. Figure 4-1 depicts this overall flow.

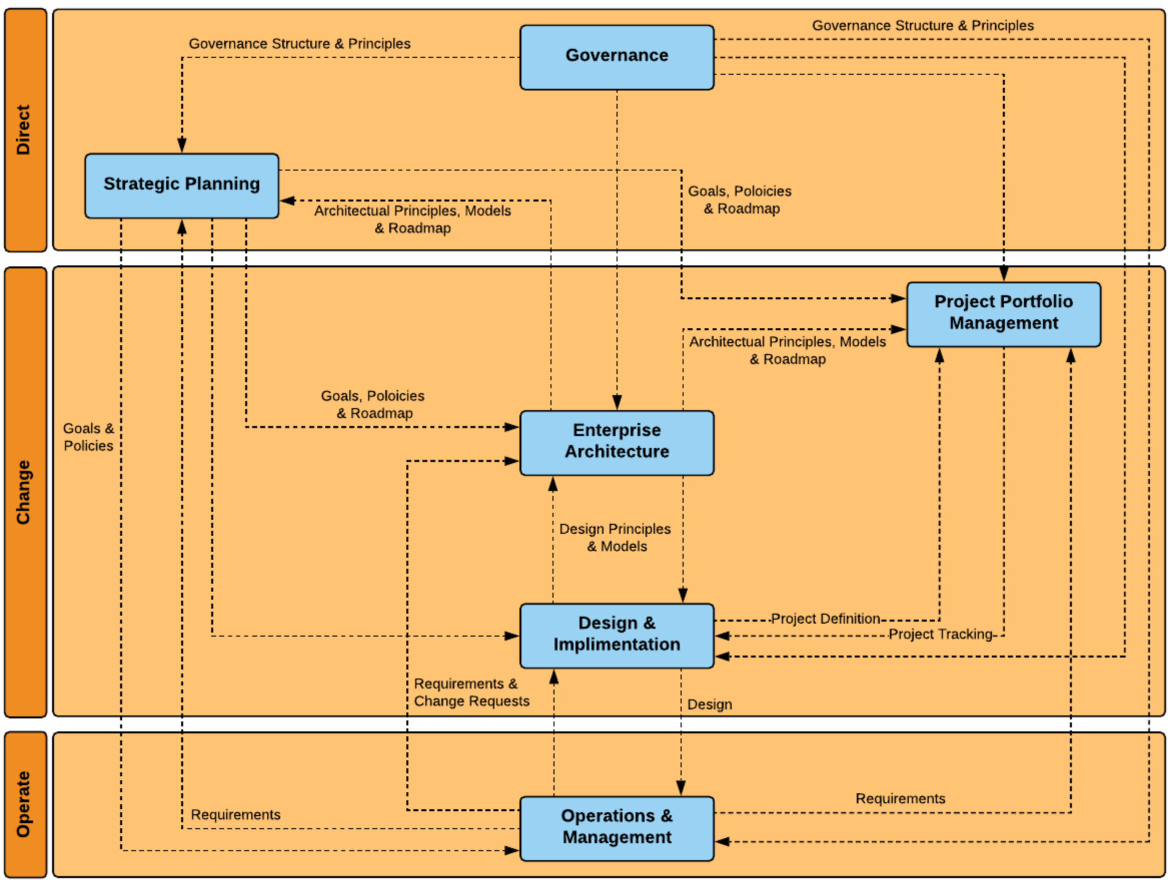


**Figure 4-1**
**High Level Business Process Flow Relationships**

Some of the most widely recognized, vendor-neutral, third-party frameworks can be mapped to each of these major areas of business process flow. COBIT is typically an IT governance and control set of standards. TOGAF is an Enterprise Architecture framework. ITIL focuses on operations as a defined set of detailed practices for ITSM (IT Service Management). Each set of standards is briefly defined here with a link to wiki pages as footnotes.

COBIT:[3] **Control Objectives for Information and Related Technologies** is a good-practice framework created by international professional association ISACA for information technology (IT) management and IT governance. COBIT provides an implementable "set of controls over information technology and organizes them around a logical framework of IT-related processes and enablers.

TOGAF:[4] **The Open Group Architecture Framework** is a framework for enterprise architecture that provides an approach for designing, planning, implementing, and governing an enterprise information technology architecture.[2] TOGAF is a high level approach to design. It is typically modeled at four levels: Business, Application, Data, and Technology. It relies heavily on modularization, standardization, and already existing, proven technologies and products. TOGAF was developed starting 1995 by The Open Group, based on DoD's TAFIM. As of 2016, The Open Group reports that TOGAF is employed by 80% of Global 50 companies and 60% of Fortune 500 companies.

ITIL:[5] formally an acronym for **Information Technology Infrastructure Library**, is a set of detailed practices for IT service management (ITSM) that focuses on aligning IT services with the needs of business. In its current form (known as ITIL 2011), ITIL is published as a series of five core volumes, each of which covers a different ITSM lifecycle stage. ITIL describes processes, procedures, tasks, and checklists which are not organization-specific, but can be applied by an organization for establishing integration with the organization's strategy, delivering value, and maintaining a minimum level of competency. It allows the organization to establish a baseline from which it can plan, implement, and measure.

While each of these standards has its primary areas of focus there is also much overlap across content and process areas covered. There is no easy recipe to follow and defining a utility's best case specific plan will certainly take significant focus, effort and time. An organization will need to fully embrace and define a plan it can own comprised of the best and most relevant components and examples of industry tools and best practices. Working through such organizational business process changes is never easy and certainly touches on Business Transformation and in some cases may require a significant restructuring of the businesses operations. Taking the time to fully allocate a team of experts with a clear executive sponsor is very important. The goal is to come up with an efficient framework that matches the organization's needs over time. It is important to avoid simply defining multiple layers of overlapping standards and tools that tend to blur ownership and efficiency.

## 4.4 Utility Telecom Planning Examples

Throughout the course of this project we have had several conversations with utilities regarding their Telecom organizational history, structure, tools, processes, and challenges. This section highlights some of those discussions and their experiences as they are progressing through the implementation of a Telecom Planning structure. It will also point out some of the common themes and trends we are seeing with regards to utility Telecom organizations within the industry.

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[3] https://en.wikipedia.org/wiki/COBIT

[4] https://en.wikipedia.org/wiki/The_Open_Group_Architecture_Framework

[5] https://en.wikipedia.org/wiki/ITIL

The utilities interviewed and basic information on their size are listed below in alphabetical order:

- Ameren employs approximately 8,500 individuals and provides energy services to approximately 2.4 million electric customers and 900,000 natural gas customers across 64,000 square miles in Illinois and Missouri.
- American Electric Power (AEP), through it seven utility subsidiaries, serves over 5 million customers in 11 states. AEP also has the nation's largest transmission system.
- FirstEnergy employs more than 15,600 employees and is one of the nation's largest investor-owned utilities, comprised of ten electric distribution companies serving over six million customers and covering 67,000 square miles of service territory.
- Hawaiian Electric Company, and its subsidiaries, Maui Electric Company, and Hawaii Electric Light Company, serve 95% of the state's 1.4 million residents on the islands of Oahu, Maui, Hawaii Island, Lanai and Molokai.
- Salt River Project (SRP) provides electricity to approximately 1 million retail customers in a 2,900-square-mile service area that spans three Arizona counties, including most of the Phoenix metropolitan area with approximately 5100 employees. SRP is an integrated utility, providing generation, transmission and distribution services, as well as metering and billing services.
- Southern California Edison (SCE) employs approximately 13,500 individuals and provides energy services to approximately 15 million electric customers across 50,000 square miles in California.

### 4.4.1 Example Utilities' Telecom History & Organization

Telecom engineering at one of the utilities interviewed originated as an organization that provided control and voice circuits at power plants and then evolved to become the provider of private network telecom services across the WAN. As it grew in size, the telecom group divided into two functional teams, one for engineering and another responsible for operations. Eventually, the entire telecom group was brought inside a larger Information Technology unit.

As a result of the increased awareness of the critical nature of IT and telecom to the enterprise, this utility created the position of Chief Digital Officer, or CDO. The portion of this utility's org chart related to telecom is in Figure 4-2.

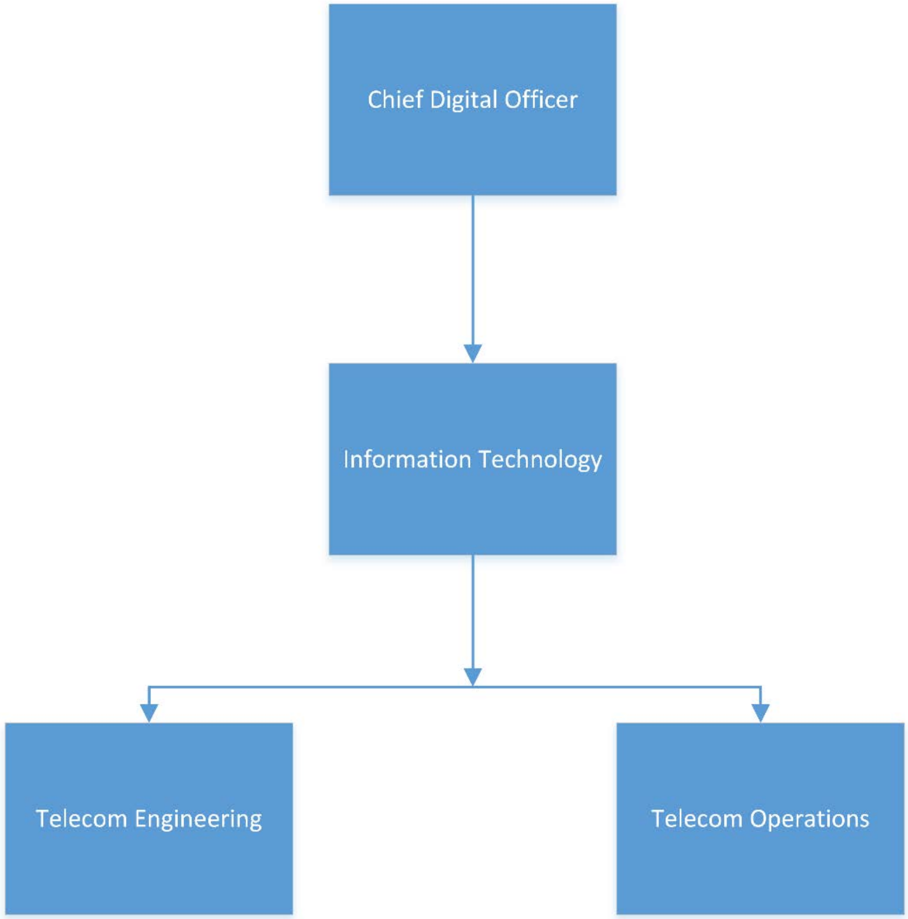


**Figure 4-2**
**Utility Telecom Org Chart Example 1**

The next example utility described an organization that has grown as a result of not only the use of telecom for internal operations but through the success of a dark fiber business that expanded not only in geographic reach, but also in innovative offerings. The latest is the hosting of containerized data centers adjacent to substations. At any rate, the telecom groups are located under the utilities Transmission organizational structure. The org chart for this utility is shown in Figure 4-3.

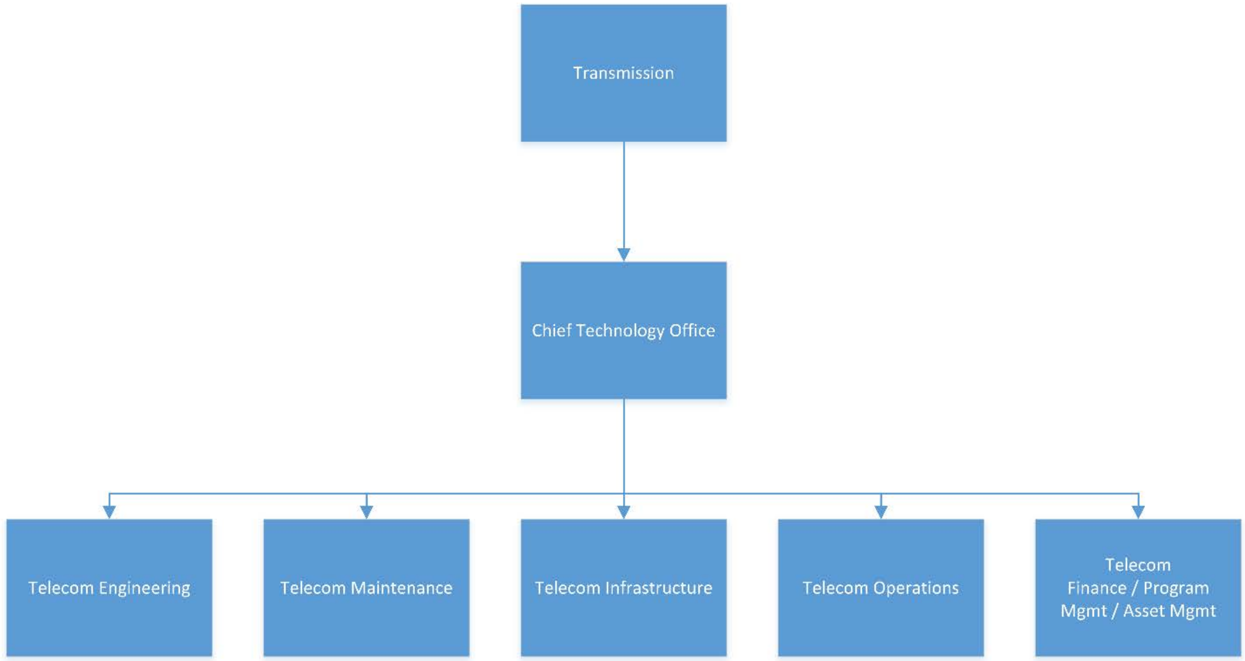


**Figure 4-3**
**Utility Telecom Org Chart Example 2**

At another utility telecom organization, the group began as an internal unit responsible for maintaining land mobile radio systems but then grew to assume the additional role of engineering, installing, and maintaining connectivity for teleprotection. This was built originally with two-conductor, open-wire lines and reached throughout the service territory. Not long after an IT organization was created to support business operations, including billing, telecom was consolidated into this centralized functional group.

This utility outsourced much of the traditional IT functions, which is shown via the dotted line in the org chart in Figure 4-4.

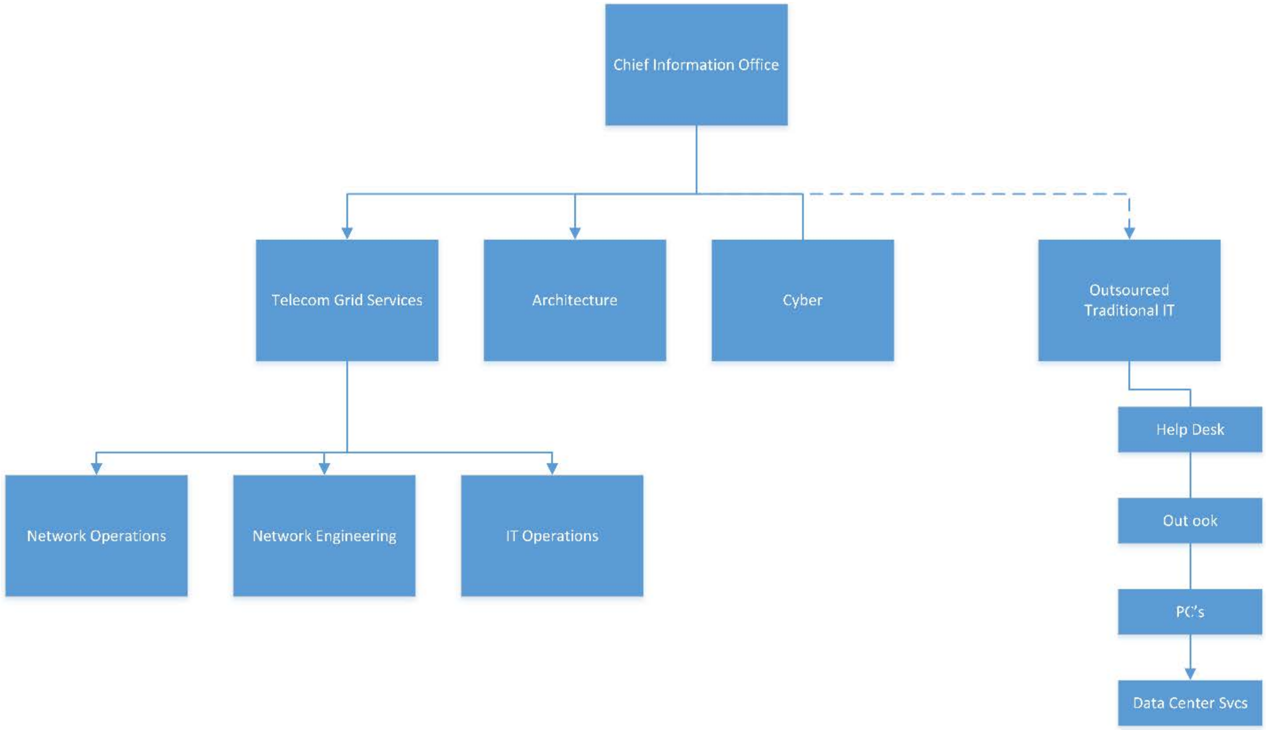


**Figure 4-4**
**Utility Telecom Org Chart Example 3**

A different utility reports that telecom originated under an administrative services organization and focused on wireline telephone, land mobile radio, and mainframe computer interconnection in the late 1980's and early 90's. This utility has a complicated history of mergers and acquisitions and a parallel history of many iterations of telecom functional organizations and re-organizations. The final result was that telecom became managed under IT where it has since remained. The IT organization itself has evolved. At one time there were two primary groups, one for engineering and design, and the second that was responsible for implementation, operations, and maintenance. This has been reorganized to the current structure of one group for IT Networks and the other for OT Networks (see Figure 4-5).

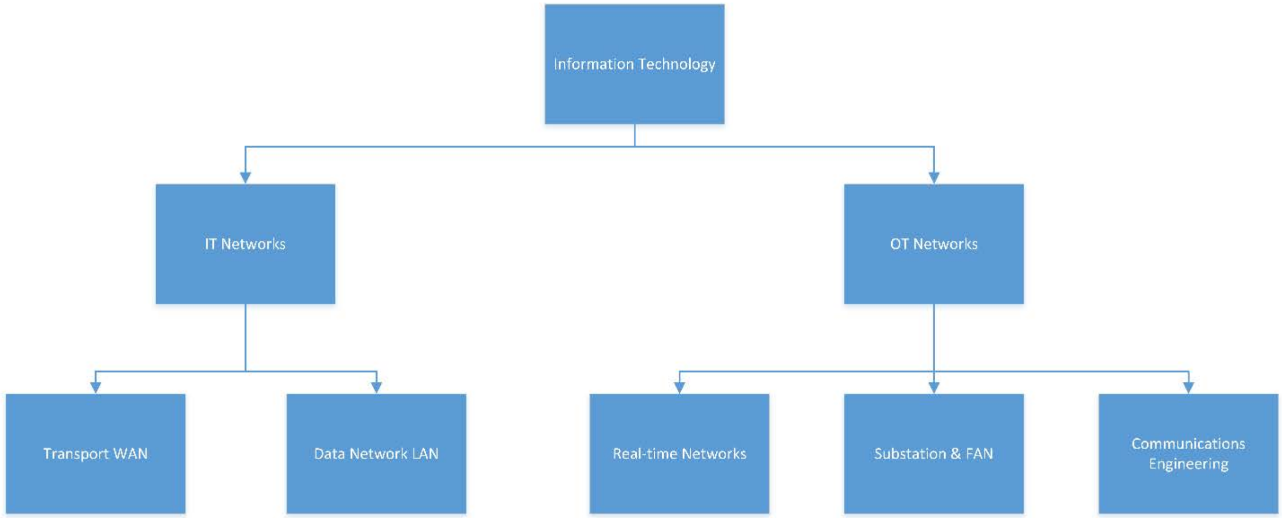


**Figure 4-5**
**Utility Telecom Org Chart Example 4**

Additional detail on this utility is that the IT Networks group manages the traditional corporate and other core communications functions and is generally split to align with the OSI reference model. A "Transport-WAN" group is responsible for Layers 1 and 2 – including fiber, microwave, two-way radio, SONET, DWDM, MPLS, and other transport systems. A second "Data Network-LAN" group covers Layer 3 networks – including routing, switching, wireless, and voice & video operations for over 200 company facilities.

The OT Networks group are three hybrid teams that are each focused on specific networks supporting operational technologies. The Real Time Networks team supports EMS/GMS and is heavily oriented toward assets with a high degree of NERC CIP compliance. The Substation & Field Area Networks team supports wireless, mesh, and cellular networks that provide monitoring & control to substations and line devices. The Communications Engineering team supports DC power systems, generators, towers, circuits, documentation/drafting, and other supporting functions.

System Operations is structured under a separate Director where applications, servers, infrastructure, and networks are monitored and trouble tickets are generated and fed back to the corresponding support teams for corrective action. Information Technology functions are currently organized around one VP covering IT Operations and another VP covering IT Business Systems, with telecom currently falling under IT Operations.

Another example utility has a structure that contrasts with the previous. Telecom Planning is recent creation (2012) that is inside the corporate organization that serves multiple operating companies. The Telecom Engineering functions reside inside the individual operating companies, which is where project execution occurs. The telecom related org chart for this utility is show in Figure 4-6.

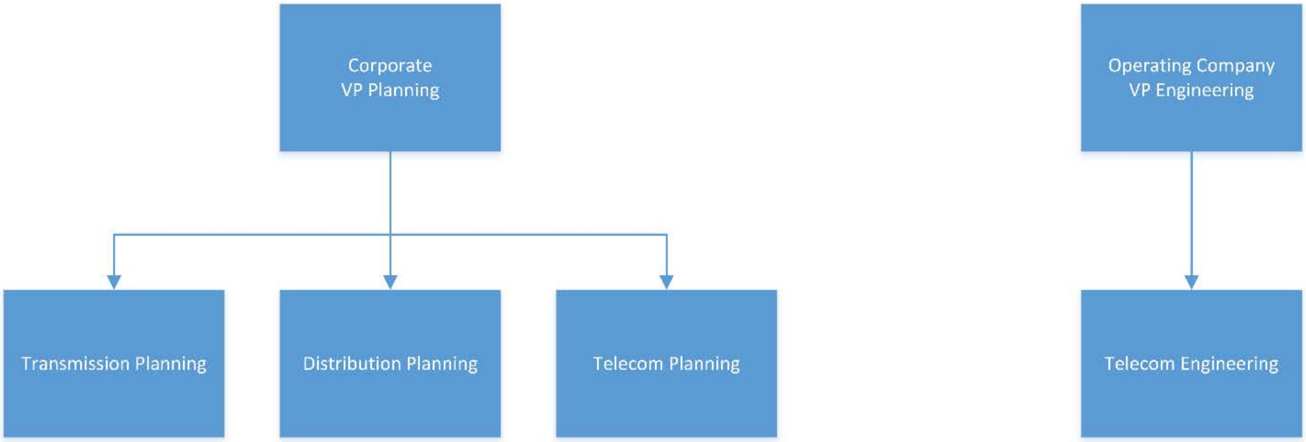


**Figure 4-6**
**Utility Telecom Org Chart Example 5**

The final utility telecom organization example is from a large IOU that has reorganized the structure several times in the past eight years. The situation in 2010 was that Telecom Field Operations were under different leadership than Telecom Engineering. This was changed in 2012 with field operations and engineering merged together under the same organization. The Network Operations Center was also moved from the IT Service Desk into the combined Telecom organization. In 2014 a Business Office was created to handle all of the telecom back office functions such as reporting, billing, work orders, and other administrative functions.

In the past two years capital project budgets increased by a factor of 20 and necessitated the creation of a Planning department and a Project Management Office dedicated to telecom. Other organizational changes were made at that time and the current structure is shown in Figure 4-7.

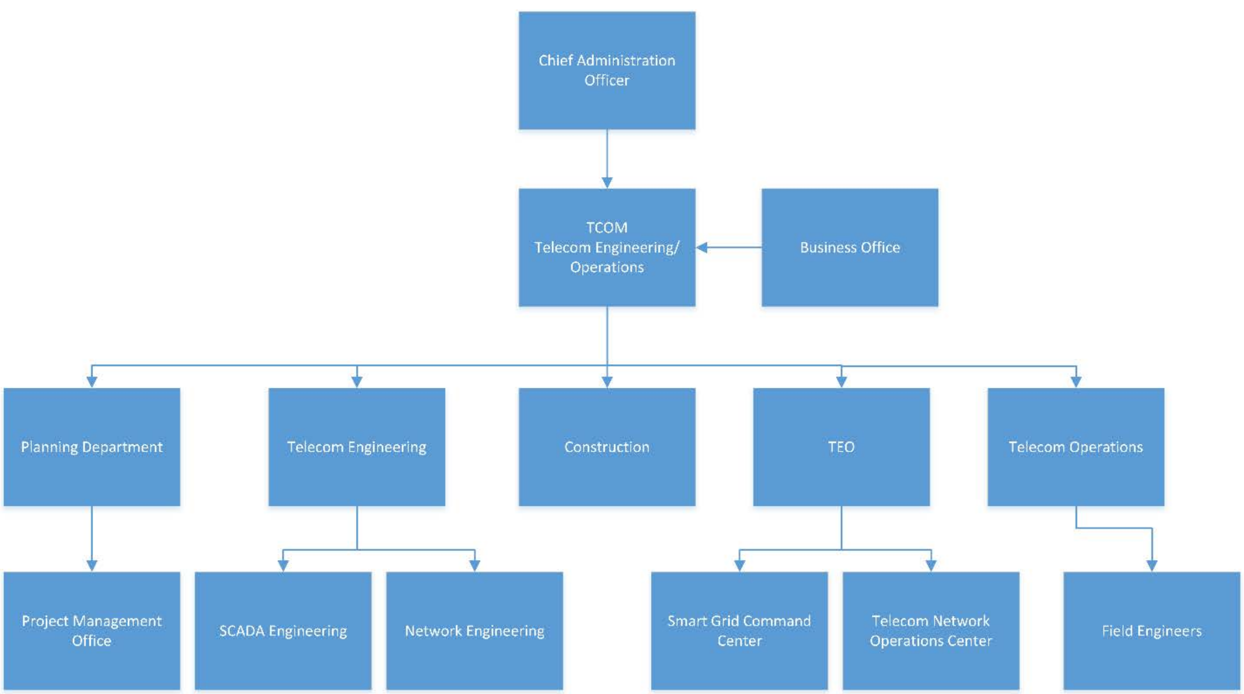


**Figure 4-7**
**Utility Telecom Org Chart Example 6**

### 4.4.2 Example Utilities' Telecom Successes

The first utility reported that strong executive sponsorship for telecom projects has been extremely helpful in providing the teams with the needed resources to improve project delivery.

This utility also has invested in the development of tools and process to both model and define the value of projects in terms of SAIDI, SAIFI, and Customer Benefits. One example uses Oracle OPPM, initially looking at extending fiber into the distribution system, but will eventually evolve the concept into a common method to articulate the value of any technology project. These tools help to simplify the decision-making process, project approvals, and prioritization. Other examples are implementing EDX, RF Map overlays into GIS, and drive testing to aid in deployment planning and optimization.

Another utility also describes the benefits of strong support and leadership at the executive level. They have created an Enterprise Telecom Strategy to optimize efficiencies across all communication systems. A major focus area that has proved helpful is the common network management that provides one consistent source of truth across the networks.

A different utility found that there was a need for more comprehensive Systems Engineering that considered designs across all aspects of the operational technologies. To address this an Architecture group was created that is tasked with following projects through to deployment. This is effectively migrating this group back to more of a Systems Engineering organization.

One of the example utilities has seen improvements in successful telecom projects since network personnel perform all aspects within their respective technology areas – including engineering, design, planning, implementation, operations, and maintenance – both the efficiency of design and in the quality of field implementation has improved. There is great value in the designers owning their own implementation and changes, and knowledge gained from both implementation and supporting trouble tickets improves the quality of designs. This also improves employee satisfaction, since there is a larger on-call rotation that would be if operational groups were dedicated.

This utility also has Telecom tightly integrated with the capital planning process of the transmission and distribution businesses and is becoming a significant percentage of the overall capital spend due to technology obsolescence in the telecom industry and regulatory mandates from the FCC to move away from legacy communications systems. The teams are also highly matrixed within the operational business units where members regularly attend T&D operations staff meetings promoting strong team collaboration across different organizations. Telecom requirements are integrated into numerous other capital projects funded within the business units (e.g. transmission line rebuilds, substation upgrades, new facilities, etc.), so the portion funded directly within IT is relatively small.

Situational awareness and the ability to quickly and accurately determine what is happening in the network and where it is happening is a key driver to tools and system evolution. NetScout and enhanced GIS systems are two areas in which investments are being made in this regard. The ability of NetScout to quickly and accurately determine root cause for a system problem has proven its value again and again in the ability to rapidly isolate and resolve system issues. The evolution of the GIS is a more recent project that is targeting real-time visualization of the transport network to improve Operations, Planning, and Engineering.

An important reported success by one of the interviewed organizations is that their operating companies and even outside stakeholders have been made aware that telecom systems are a key component of the Grid Modernization Plan.

The utility that recently created a Planning Department, PMO, and Business Office, all dedicated to Telecom reports improvements in being able to form a long term view of stakeholder needs, achieve close collaboration with engineering and construction, and is experiencing better project execution and scheduling with business units.

### *4.4.3 Example Utilities' Telecom Challenges*

From one of the interviews it was learned that the telecom organization is experiencing challenges in several areas. The first area is the recognition that the current processes tend to result in fragmented responses to developing solutions. There is discussion around forming a Telecom Planning organization to resolve this issue. The lack of such an entity creates an environment in which those needing Telecom do not really know who to talk to and then once a project is defined it is usually a "needed it yesterday" scenario and since it was not planned the Telecom Teams cannot react fast enough to meet the needs. Telecom may remain in IT or there is a possibility that they could move over to Transmission due to a stronger Program Management set of competencies within that organization. Another trend that they are experiencing is that as the older workforce retires and new engineers are hired a greater number of diverse technical skills are being staffed within the operational units and less in IT. In these cases, IT tends to focus more on the networking aspects and less on the actual technology implementations.

Another utility did not report any issue that is unique, though they are at the beginning of deploying a FAN after completing a comprehensive selection process. Their challenge is in ramping up the program and meeting the timelines required by internal stakeholders.

And another utility reports that it has resolved an issue with its organizational structure that was producing sub-optimal results. Some additional detail on that issue was that the previous structure segmented system implementation into the T&D organizational units. This left knowledge gaps when systems were implemented and a loss of continuity from the initial design to the final procurement. In some cases, system level interactions were missed as individual systems procured by T&D were found to conflict with existing systems communications. The resolution has been with the creation of the Architecture group that is tasked with staying involved with new systems all the way through deployment.

The biggest challenges for another revolve around communications and process integration across all the teams given the large and diverse service territory, regulatory jurisdictions, and systems within their operating regions. There is a constant effort to reduce process bottlenecks and improve overall communications. Another area of significant challenge is the attrition of qualified people. Both the advent and rapid integration of more sophisticated systems combined with the retirement of the legacy knowledge base poses a significant challenge to build and maintain skilled teams.

A final observation from another is the need to improve their processes and tools. Currently they use items such as SharePoint, and spreadsheets to manage telecom project requests. While the concept is sound, it lacks a compressive awareness of projects across the companies and is "voluntary" with no real no consequences for not following the process. Many operating units still deploy technology based on their applications view and needs without a disciplined system engineering oversight to ensure compatibility across dependent systems and architectures. They understand that they in the early stages of implementing a Telecom Planning process. Some key areas of focus are evolving cross organizational communications and moving from a voluntary input to planning to a more formal standards based approach similar to operational planning.

## 4.5 Selecting a Grid Modernized FAN System

This section discusses the learnings and recommendations from RFP and vendor selection experiences with several utilities and can be used as a guide to help with FAN Grid Modernization.

It is well agreed upon within the energy industry that there is a need to improve the performance, reliability, and security of utility communication systems used for Distribution Automation, Telemetry, and Control. Such a Communications Network is a highly complex system comprised of both wired and wireless systems, firewalls, routers, data centers, and security mechanism that span a large and diverse geographic area. Many technology and architectural options can be applied in varied combinations to meet this objective. It is also a system that can be implemented in more than one way with more than one set of technologies. There is no single correct answer, but rather multiple solutions that will meet the needs of the utility. The difficulty of selecting an architecture is also compounded by the diversity of non-standard and standard technologies as well as the complex and fast-moving pace of new technologies. The *Utility Telecom Wireless Taxonomy Document*[6] can help a utility understand the set of choices and architectures that are currently available.

Once a baseline architecture is determined, a set of requirements and an RFP process can be initiated. A significant effort was completed by SCE to create a FAN RFP and a clean version was submitted to EPRI as part of the Telecom Initiative. This document provides a great starting point for any FAN RFP. The *SCE FAN System Requirements*[7] is available to Telecom Initiative Participants.

As part of the RFP process a FAN set of system requirements aligned with the 15-year communications strategy that can be used for both procurement and evaluation of vendor technologies needs to be created. Such a list defines the basis for testing, simulation, and modeling methods and tools to progress from an RFP stage to a selection of technologies to meet the FAN requirements. The process should include:

- Requirements Generation
- RFI/RFP evaluation

[6] EPRI, Utility Telecom Taxonomy and Architecture for Field Area Networks, Product ID:3002009786, Date Published:05-May-2017, Pages:70, Sector Name: PDU – Distributed Energy Resources and the Customer, Document Type: Technical Result.

[7] SCE FAN SYSTEM REQUIREMENTS, Revision v1.0, July 20, 2016, © 2016 Southern California Edison Company.

- Test planning and implementation progressing from lab to field and scaling from small to larger scale
- Critical evaluations of vendor technical solutions against required performance and application needs
- Once a vendor has been selected, a detailed Statement of Work for deployment with final acceptance criteria clearly defined

Figure 4-8 depicts this process. It is very important to take the time to define a comprehensive set of requirements prior to generating an RFP. The RFI process is key to helping understand what the market can offer and where different vendors are relative to each other's offerings. Initial requirements based on system and projected system needs are the basis for an RFI. RFI responses can then be used to tune the RFP to better reflect what the market can offer. Typically different vendors will each have different desirable features. The best of all of these can be added to the RFP allow the utility to ask for all of the best features and then see which vendor can best meet the largest inclusive set.

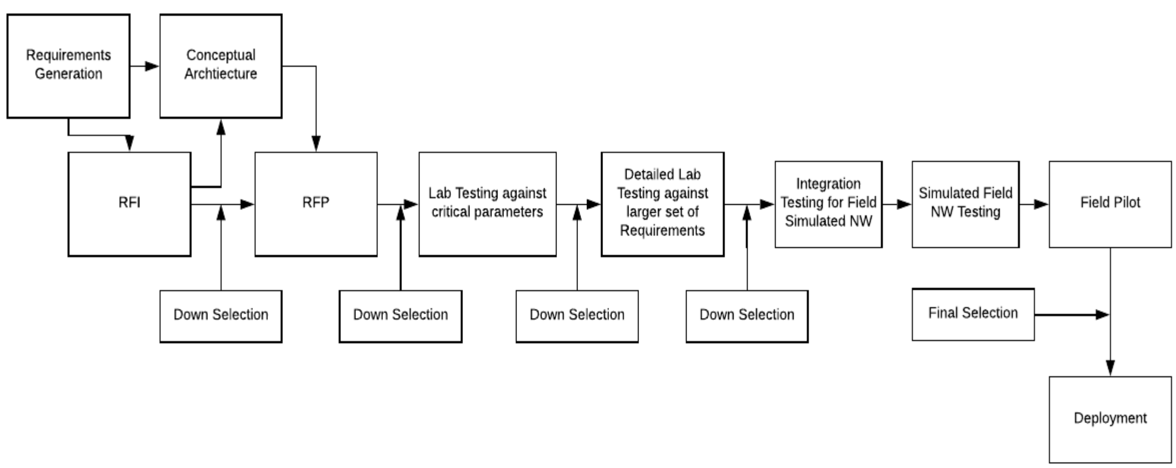


**Figure 4-8**
**FAN Procurement Process**

Testing in both the lab and in the field is critical to determine if the vendor is actually delivering what they said that they would deliver in the RFP response. In many cases the specific combinations of FAN communications technology and distribution devices have never been tested or even modeled as a complete system. Many systems both for Distribution Control equipment as well as edge DER devices will specify that they can perform at higher rates of information exchange while actual FAN systems have capacity and latency limitations. There are also many performance parameters that can be misrepresented by vendors. When these use cases are measured as they will actually be used, the system can fall short of the promised performance. Peer to Peer routing, QoS Support, IPv4/v6 support, and Adaptive Modulation algorithms are only a few such critical parameters that it is imperative to measure and test prior to signing a contract. How QoS is implemented in many such systems highlights some of the factors that can be easily missed. Many systems specify QoS functions but they are only implemented in the routing queues and not at the wireless link level. In such cases testing and evaluation can show that improper QoS implementations provides little benefit. Testing with defensible data provides the opportunity to hold vendors accountable to implementing full feature functionality prior to procurement.

Finally, once accepted after extensive lab and field testing, a FAN system can be moved into production and deployed.

# 5
# SUMMARY AND CONCLUSIONS

In this document we have discussed the concept and definition of Telecom Planning as well as a process flow to help highlight the many complex elements and capabilities needed to support the modern grid. We have also highlighted some ideas and examples of current implementations within member utilities. A few common key themes continue to surface:

- The grid is becoming more and more critically dependent on the communication network and is now a key topic at the executive level within the utility.
- Situational awareness is a key driver for faster and more comprehensive communication systems.
- There is no one best model for implementing Telecom Planning. Each utility will need to best design a plan that fits its particular culture, history, technical, and business needs.
- Strong Executive support and leadership is key to successful implementation of a Telecom Planning organization and function within a utility.
- Close coupling and joint planning with Energy Delivery Organizations is critical.

It is clear that the Telecommunication Systems of the utility are becoming as or even more complex than the power delivery system with a trend towards every node on the network eventually being connected in some way with an increasing need for more capacity, lower latency, and higher reliability. In addition, to increasing edge devices, the core networks are expanding with more and more distributed compute elements moving out to substations and edge devices. The Communication Systems are no longer an isolated small number of engineers, funded as needed, striving to react to support systems as they are deployed. The planning and budgeting of communications are now significant cost line items with clear visibility at the executive level. Significant organizations with VP leadership are being structured to design, build, fix, and operate. Telecom is quickly emerging as the “The 3rd Grid” and a key foundational cornerstone of Grid Modernization.

# 6 GLOSSARY OF TERMS

| Term | Definition |
|---|---|
| Application Profile Set | Used for Traffic Modeling. An APS is a combination of multiple Application Data Flow Sets for a specific set of conditions such as the Day Type and Event mode. |
| ATSE | Each Application that is run over the Communications System has a finite set of traffic sequences that can be defined and modeled. This includes a number of packets of a specified size and type sent in a specific sequence from a Device. There may be multiple sequences for each application called Application Traffic Sequence Events (ATSE). Packet captures from the Distribution Management System and Field Devices can be used as a basis to build ATSEs. |
| Capacity | Defined as and amount of data in bits/sec that can pass through an interface |
| Coverage | The area coverage by a wireless communication system. An availability metric defines the percentage of reachable devices and a reliability metric defines the percentage of the reachable devices that meet a defined level of performance. |
| DA | Distribution Automation: A set of technologies that enable an electric utility to remotely monitor, coordinate, and operate distribution components in a real time mode from remote locations. |
| DAPS | A list of ATSEs at specified times or intervals (may be randomized) can then be used to create a Daily Application Profile Set (DAPS) |
| Day Types | Day Types are repeatable days or periods of days (e.g. morning, night) with common operational application behaviors such as a weekday, weekend, or holiday. |
| DER | Distributed Energy Resources: Distribution-connected Devices that are capable of generating energy or storing energy for later consumption. DERs include DGs and DSs. |

| Term | Definition |
| --- | --- |
| DG | Distributed Generation are distribution grid connected Devices that generate power near the point of consumption. Most inverter-based DGs (e.g., PV and certain types of wind generators) deployed today have a simple inverter that has no communication capability and limited control capability. However, future inverter-based can be equipped with advanced inverters (so-called “smart” inverters) that may have the following functionalities:<br>4-quadrant power factor control to regulate voltage output continuously throughout the day in response to dynamic conditions.<br>Ability to communicate with Distribution Grid Operators and with other Devices on the grid.<br>Some of the currently deployed inverter-based DGs that have a simple inverter can be equipped with these advanced functionalities via a firmware upgrade. |
| DS | Distributed Storage: Energy storage units include small-scale storage Devices such as home energy storage units and plug-in electric vehicles (PEVs). Large-scale energy storage units include pumped storage, batteries, flywheels, superconducting magnetic energy storage, ultra-capacitors, and aggregated PEVs. |
| DSO | A Distribution System Operator (DSO) securely operates and develops an active distribution system comprising networks, demand, generation and other flexible distributed energy resources (DER). As a neutral facilitator of an open and accessible market it will enable competitive access to markets and the optimal use of DER on distribution networks to deliver security, sustainability and affordability in the support of whole system optimization. A DSO enables customers to be both producers and consumers; enabling customer access to networks and markets, customer choice and great customer service. |
| Event Types/Modes | Event types are specific events that may happen on a common day type or over a period of Day Types such as Bluesky conditions, Storm Conditions, Overcast, or a Disaster Event such as a Fire, Flood, or Earthquake. Identifying a set of Event Modes provides a basis to assess the needed capacity of the communications network under adverse conditions. |
| FAN | Field Area Network |
| git repository | A git repository is a collection of software code stored in github. |
| github | **Github Inc.** is a web-based hosting service for version control using Git. It is mostly used for computer code. It offers all of the distributed version control and source code management (SCM) functionality of Git as well as adding its own features. It provides access control and several collaboration features such as bug tracking, feature requests, task management, and wikis for every project. |
| KPI | A **Key Performance Indicator** is a measurable value that demonstrates how effectively a company is achieving key business objectives. |

| Term | Definition |
|---|---|
| QoS | Quality of service (QoS) refers to a network's ability to achieve maximum bandwidth and deal with other network performance elements like latency, error rate and uptime. Quality of service also involves controlling and managing network resources by setting priorities for specific types of data (video, audio, files) on the network. |
| RFI | Request For Information |
| RFP | Request For Proposal |
| Serialization Point of a Network | In mesh systems or in star systems the aggregation point is usually the serialization point of the network. (the point of the most constrained traffic which will most likely be the point at which network throughput is limited) |
| Serviceable Territory | The area of coverage necessary to cover all current and projected Devices within the Communication System. |
| Telecom Planning | Telecom Planning is defined as an organization and set of operational functions that are responsible for the reliable operation of the Utility Communication Systems. |
| Telecom System | The Telecom System defines the entire communications system for the utility. It is in fact a system of systems with multiple technologies integrating to form an overall communication fabric for the utility. It includes; fiber, phone lines, wireless systems, 3rd party networks such as LTE, and all other methods of networking different systems and applications together. |
| Traffic Model | The Communications Traffic Model is a tool that can be used to model traffic flows and capacity needs for the communications system based on grid topology, applications, and day of conditions. |

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