Building a Microwave Network for Wireless Communications

Twelve Key Points That All Project Managers Should Know

Building a microwave network involves three main phases:

- *Planning & Design*
- *Construction*
- *Final Acceptance*

With a basic understanding of key items specific to the microwave build-out process, Project Managers are assured much smoother running at each phase.

Host a kick-off party to meet each team member and brainstorm to identify missing links.

Introduction

Every Project Manager knows that the success of a venture involves the effective control of time, costs, and quality of service. Although each project has its own unique set of planning, tracking, scheduling, and management tasks, the overall process for a microwave build-out revolves around three key phases: planning and design, construction, and final acceptance. Managing such a project requires mobilizing a design and construction team to plan, and controlling and implementing all of the project's activities, from conception to completion of construction.

Thus, Project Managers must have a basic understanding of the microwave build-out process, which includes knowing what specialists to bring in as well as understanding the timeline required and critical steps toward completion. This technical paper briefly describes twelve key factors for managing a microwave network build-out project and is recommended reading for executives and the management team. Even if you're an experienced project manager in other industries, understanding the basic phases specific to the microwave network build-out process will help you better navigate its complexities.

1. Organize a Kick-off Meeting and Invite All Key Players

Regardless of whether you're charged with building a new microwave system or upgrading or expanding an existing facility, microwave deployment is a multi-disciplinary activity that involves a number of specialized experts in their respective fields. Thus, hosting a kick-off meeting that includes all project participants is both a good opportunity for people to meet one another and a great way to brainstorm to identify any missing links, i.e., necessary equipment, needed experts, or other factors that might have been omitted or previously thought unnecessary. It's better to discover such things sooner than later.

2. Select Your Team of Engineers and Consultants Carefully

Carefully engineered designs can provide years of quality service and significantly reduce a project's overall costs, including future maintenance and repairs. That's why selecting appropriately qualified transmission/microwave engineers, paths surveyors,

and construction crews is essential for achieving the best possible results. Don't be satisfied with a team's ability to merely meet the minimum standards required to do the job. Appropriately qualified engineers and/or engineering consultants will rigorously consider all design and build alternatives, analyze the long-term operating and maintenance costs, and present innovative designs for consideration.

Select the project engineers and consultants based on their qualifications to perform the assigned tasks, not on price.

A qualification-based selection method will help you choose the company (or companies) who can provide engineers. The selection method should demonstrate the engineers' competence in performing their required services. Choose the company that is best qualified for the job, which isn't always the one with the lowest-priced offer. If possible, select a company who can provide in-house experts in all phases of microwave network design and deployment. Only a handful of companies provide these turnkey services, and using one as your single supplier will ensure that the entire project is properly coordinated to achieve the highest quality standards while also controlling costs and scheduling.

Choose a company who can provide experts in all aspects of the network build-out design and deployment.

3. Create a Preliminary Network Plan

While either the engineers or the Project Manager can do the scheduling and budgeting, the network plan—also called a preliminary design—is typically done by the microwave engineers. Who performs which function depends on how responsibilities are delegated and can vary from project to project. By and large, a network plan can be completed in a matter of days and usually consists of the following:

The preliminary network plan is the basis on which the whole project will be accepted or rejected. Unfortunately, the margin for error is high based on several factors.

- A thorough discussion of the system requirements and the project goals. The client defines the system requirements and often the site locations as well.
- A preliminary engineering of the path using topographical maps and a visit to key sites only, such as switch offices and big hub sites.
- A list of the required materials and a preliminary BOM.
- A budget and timeline with clearly defined benchmarks.

The whole project will be assessed—and approved or rejected—on the basis of the preliminary network plan and its deliverables (budget, work force, and schedule). Unfortunately, due to the short time in which the information is gathered, as well as the limited input data, the margin of error in the plan calculations and its predictions is quite high. Thus, getting approval is probably the most difficult part of the project because you must convince non-technical personnel or executives—who may not have the funds and/or experience with the technology involved—to go ahead with it. Understandably, they can be nervous about committing large amounts of capital for something that might not bring profits (or likewise not break even) for a few years.

4. Hire a Good Site Acquisition Expert

With increasingly more restrictive zoning requirements and a host of new wireless operators rushing to install thousands of new cell sites in communities large and small, getting permission to use the most appropriate microwave sites can be a tall order. In addition, zoning regulations differ from jurisdiction to jurisdiction, so negotiating with public officials and civic administrators requires considerable time and leasing experience.

For most wireless network build-out projects, complex zoning regulations are the main bottleneck in acquiring appropriate microwave sites—taking up to six months or even longer. Therefore, qualified site acquisition experts are worth their weight in gold.

Make sure your team includes an expert who knows how to navigate the complexities of site acquisition, which is the main bottleneck in deploying microwave networks. It can take up to six months, or longer, to acquire an appropriate site. However, tools and processes are being developed that increase siting flexibility without deteriorating coverage, capacity, and service quality. Your site acquisition specialist should be aware of them and use these tools to the project's advantage. This person should also have the necessary diplomacy skills to work with a number of different people in finding solutions and resolving potential conflicts.

5. Create a Detailed Network Design

A microwave radio system requires careful planning and detailed analysis before the equipment can be installed. A poorly designed path can result in periodic system outages, resulting in increased system latency, decreased throughput, or worst case, a complete failure of the system.

A detailed network design is essential and should include comprehensive path and site surveys, link engineering, interference analysis and radio licensing, and final equipment specifications. Procure the necessary equipment and services as soon as possible and stay within budget.

Because not all the sites will be suitable for tower and microwave antenna installation, site and path surveys and link engineering are interdependent. Further, any changes in site location can seriously impact network topology and design. A field path survey should determine the exact coordinates where the antennas will be located, the height of each antenna, the location and height of current and future path obstructions (for example, a tree could grow to obstruct the path at some later date), and the location of possible reflection points. For more comprehensive information on conducting a thorough path survey, refer to CIC's white paper on the topic: *Determining Accurate Microwave Path Performance: Why a Formal Path Survey Will Save Money*.

A detailed network design should consist of:

- Comprehensive site and path surveys
- Link engineering
- Interference analysis and radio licensing
- Final equipment specification for the BOM

6. Procure the Necessary Equipment and Services

Having a good Materials Coordinator is key to a successful implementation plan.

Equipment to procure generally includes (but is not limited to) antenna mounting structures (towers, masts, tripods, etc.), microwave radios, antennas, transmission lines, multiplexing equipment, cross-connects, rectifiers, and batteries. Services to procure generally include (but are not limited to) those of consultants, microwave engineers, project managers, construction managers, a site acquisition team, and equipment installers. It is important to line up all the necessary equipment and services as soon as possible and to stay within budget.

7. Hire a Good Materials Coordinator

All equipment should be protected on site as appropriate. Both custom-built and specially designed shelters should be considered where necessary. If equipment must be stored on site before installation, make sure it is adequately protected from theft, especially those containing any copper that can be removed and resold.

The key to a successful and efficient implementation plan, especially on large projects, is having an experienced Materials Coordinator. This person is responsible for ordering all required materials and equipment as well as scheduling and managing its delivery. The Materials Coordinator must understand the technology, and even more importantly, the process of implementing a large microwave network. Another duty might include making sure that equipment is safely stored on site while waiting to be installed. In some cases, remote sites might require private security to guard expensive microwave equipment like valuable copper waveguides, for instance, which are sometimes targeted by thieves.

8. Install the Equipment and Test It

Telecommunications equipment comes in all shapes and sizes, and specially designed, or even custom-built, shelters are available to properly protect it. In addition, new split-configuration microwave radios require little space and can be installed virtually anywhere. Installation may include some or all of the following:

- Erecting towers or tower upgrades
- Installing antenna and transmission lines
- Installing radio or other transmission equipment

Test the equipment after it is installed before commissioning and hand-over to the client.

Following installation, all equipment must be tested. In addition, a record of the standard field turn-up tests—as defined by the client, agreed upon by the microwave supplier, and performed after installation is complete—must be provided to the client. Individual microwave links must be tested for a short period of time (a few hours), while the system acceptance end-to-end tests should be performed over a 24-hour period. In case of protected (1+1) configuration, the protection switching should be tested for correct functioning as well. More detailed information on testing and acceptance of transmission systems can be found in *Transmission Systems Design Handbook for Wireless Networks*, by Harvey Lehpamer (2002, Artech House).

Though a properly designed system should not require much upkeep, a periodic maintenance plan will ensure long life and prevent problems down the road.

All network build-out projects inevitably change in scope as the project progresses. Keep track of each change and inform all relevant parties of the consequences, most of which will more than likely affect the bottom line.

9. Commission the System

Once the "as-built" documentation is ready and the system acceptance tests have been performed, the system can be commissioned. The as-built documents show all the details of how the system was actually installed and connected, not the way it was originally designed. Commissioning involves systematically bringing the network's various components into operation before its start-up and formal hand-over to the client. Typically, whoever will be operating the completed network (the client's own team or a third party) will also carry out the commissioning and start-up procedures.

Commissioning high-capacity links (backbone systems), hub sites, and ring sites should be performed first, followed by lower-capacity and spur sites. As soon as the equipment is operational and tested according to the Acceptance Test Procedure (ATP), the Project Manager initiates and submits a final project certificate for acceptance to the client. This certificate records the formal hand-over of the completed project and identifies all the documentation that the client requires for on-going operation, including operational and maintenance manuals, as-built drawings, equipment warranties, and contract completion reports.

10. Implement a Periodic Maintenance Program

Although a properly designed and installed microwave system should not require a lot of maintenance, a periodic maintenance program should be implemented anyway and established during the preliminary design phase. The client, or any designated company, can perform the maintenance as long as they are qualified to do so. Invest in a good network management system and install it together with the microwave radio equipment. It will simplify the maintenance tasks and automate periodic maintenance-logging and record-keeping. Periodic routine maintenance for any equipment should be performed in accordance with the relevant equipment manuals and manufacturers' requirements.

11. Carefully Manage Any Changes, Document Their Expenses and Consequences

A microwave network build-out will inevitably require changes in scope at some point during the project; therefore, managing these changes, scheduling each phase, and tracking the progress are essential. RF cell-site network design and transmission network design usually change so often during the initial phase of the project that it is difficult to track all of them on a daily basis. Changes can be costly, so anyone requesting changes must understand the impact of each and be willing to accept the consequences. For example, if changes affect the time of year the system is engineered and built, it could dramatically increase the cost. Under ideal weather conditions, small networks—a dozen links or so—usually require just a few weeks from start to finish. During winter, however, a project could take two months, significantly increasing the

cost per link. In temperate or cold climates, design and installation in winter is not recommended due to various factors that slow down the project. However, in regions where temperatures don't dramatically drop during winter, this might not be an issue.

As each benchmark is achieved, be sure to acknowledge those who contributed. Upon completion of the entire project, celebrate with the whole team at a special get-together.

12. Celebrate Achieving Benchmarks

One way to ensure momentum on large-scale projects is to celebrate benchmarks as each are achieved. Recognizing successes goes a long way in team building and promoting good morale among everyone involved in the project. Organize a group lunch or get together for a happy hour. Events like these are a good way for Project Managers to personally and publicly acknowledge the contributions of each team member and exchange information that might make the project run even more smoothly. Never use these events to point out faults or mistakes. If necessary, such actions should be done privately and involve the relevant parties only. It's also important to celebrate the project's completion, inviting everyone who contributed, no matter how briefly, to help reach the end result.

Conclusion

A clear understanding of the microwave network build-out process is essential for the successful implementation of a project, whether it is a new system or an upgrade/expansion of an existing one. The key to success lies in hiring a team of experts with the appropriate skills and knowledge, carefully managing timelines and costs, and ensuring that the system meets all the construction, testing, and performance requirements to fulfill the client's goals.

About Communication Infrastructure Corporation®

CIC is a leading provider of infrastructure engineering and development services for the wireless telecommunications industry, specializing in the design and deployment of wireless backhaul solutions. We offer site development, microwave/RF engineering, installation, maintenance, and AWS relocation solutions for the efficient design and deployment of both large- and small-scale networks. Our expert team of 100+ professionals employs the latest appropriate technologies, the highest quality service, and the most up-to-date knowledge to meet the demands of wireless carriers. CIC can provide all of the services described in this paper. To learn more, visit www.cicusa.com.

About the Author

CIC's senior transmission engineer Harvey Lehpamer, MSEE, has more than 25 year's experience in planning, designing, and deploying wireless and wireline networks, including microwave, fiber optic, and other transmission systems throughout the world. He is the author of key texts in the industry: *Transmission Systems Design Handbook for Wireless Networks* (2002 Artech House); *Microwave Transmission Systems Planning, Design and Deployment* (2004 McGraw-Hill); and *RFID Design Principles* (2008 Artech House). Mr. Lehpamer also teaches courses in algebra and trigonometry at Southwestern College and microwave transmission engineering at UCSD Extension, both in San Diego.