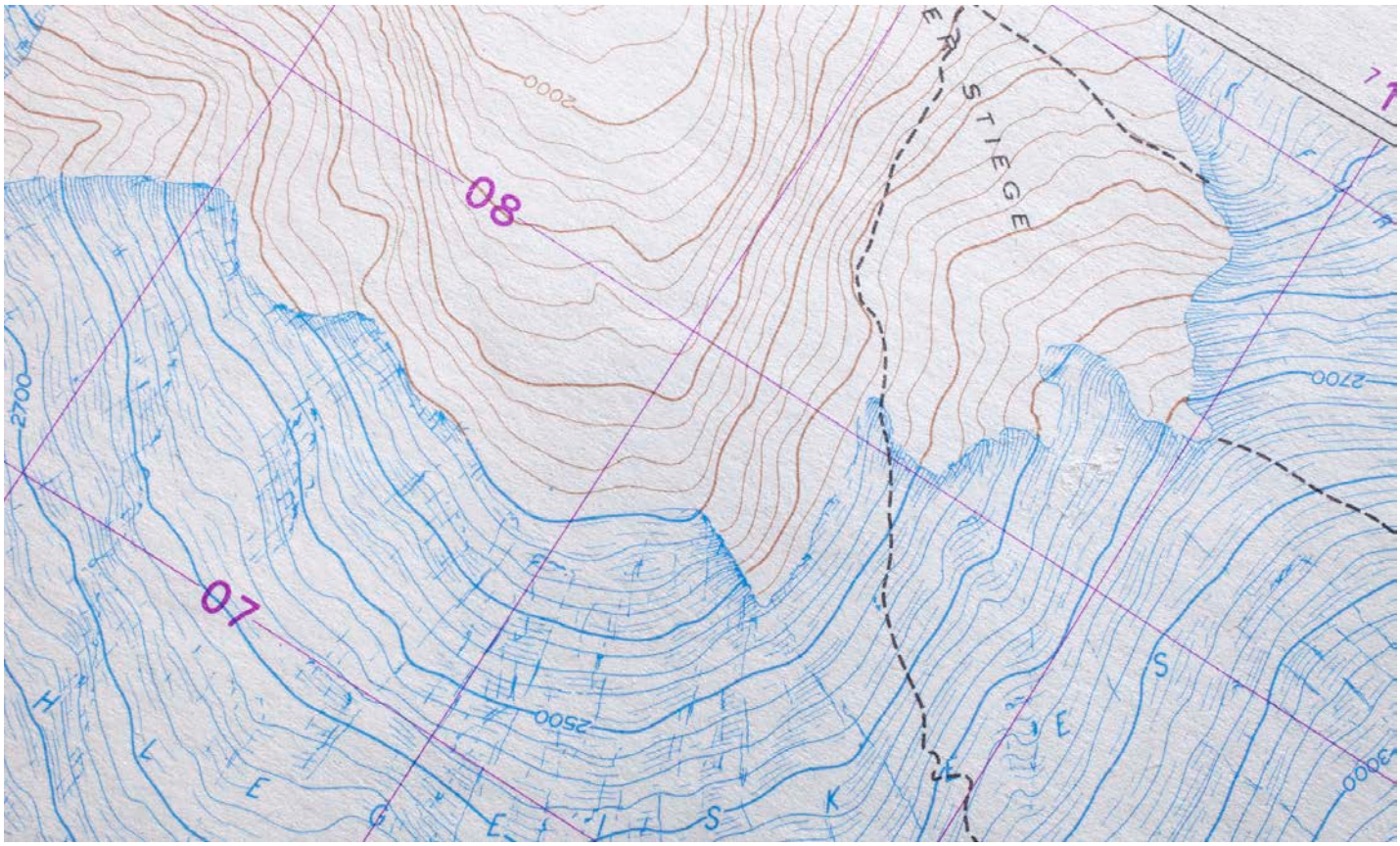
BEST PRACTICE GUIDE

Three Steps to Define Coverage Goals for a Successful Project



WHY ARE ACCURATE COVERAGE GOALS SO IMPORTANT?

Without doubt, the single most important property of any radio network is coverage. Coverage engineering may be the most complex area of the radio system specification and design process and is one critical area where your time investment will be well justified.

There are a few simple rules to doing it right, but many ways to get it very wrong. Coverage goals that are ambiguous and unclear create ongoing frustration, project delays and often, unnecessary expense on both sides.

It is critical to define coverage goals accurately, so that system engineers can design, test and verify that the new network is exactly what is wanted and needed. Your properly-defined coverage goals sow the seeds for a successful project and happy users.

A properly-defined contractual coverage goal must be:

- able to be designed against, so both parties know when the design meets the goal,
- testable and repeatable, so coverage can be tested against the goal once the network is built,
- unambiguous, so it is clear to both the vendor and the customer when the goal has been met.

THREE STEPS TO SUCCESSFUL COVERAGE GOALS

For coverage engineers to design a radio system, the coverage goals must include these three critical elements:

1. **What is the minimum acceptable quality of service?**
   You can define this as one (or more) of the following, which together describe what a user can reasonably expect:
   - Received Signal Strength (RSSI) can be used for analog or digital, voice or data radio systems.
   - Delivered Audio Quality (DAQ) can be used for analog or digital radio systems – usually for voice communications.
   - Bit Error Rate (BER) can be used for digital voice or data communications.
   - Message Error Rate (MER) can only be used for digital radio systems – usually for data communications.
2. **How much area reliability?**
   This is the average reliability of communication within the service area.
   - If service (or covered) area reliability is 95%, a user anywhere within that area has a 95% chance that they will have the minimum or better acceptable level of service.
   - Reliability is usually 90% for Utilities and 95% for Public Safety systems.
3. **Where must this occur?**
   This can be defined as either:
   - Covered area – the area within which communication is predicted to meet or exceed the minimum criteria,
     or
   - Service area – the area within which coverage has to meet or exceed the minimum criteria.

EXAMPLES OF PROPERLY WORDED COVERAGE GOALS

These goals clearly define each of the three critical elements.

- **"The network shall provide DAQ3.0 with area reliability of 95% across the entire service area."**
- **"The network shall deliver 2% BER to 95% of all locations defined by the vendor as covered."**
- **"The network shall cover at least 70% of the service area with area reliability of 99%. The minimum RSSI shall be 107dBm."**

(In all of these examples, RSSI, DAQ, BER and MER are interchangeable, as are service area and covered area.)

EXAMPLES OF POORLY WORDED COVERAGE GOALS

These are likely to lead to misunderstanding between vendor and customer, and are difficult (or impossible) to test – when the network is built, the vendor cannot prove they meet coverage goals

- **"Coverage must be the same as or better than the existing network"**
  - This is understandable as it appears to cover against all eventualities but it is impossible for the vendor to design to, or prove.
  - Even when a coverage test on the existing network shows that the new network has better reliability, coverage only has to be worse in one location and the vendor has failed the requirement.
- **"The network must deliver an RSSI of -105dBm or better across 80% of the service area."**
  - This goal lacks an area reliability target. In theory, a vendor could meet this goal with only 1% area reliability, so the resulting network is therefore useless to the customer.

OTHER THINGS TO CONSIDER:

There are many other aspects that customers and coverage engineers need to consider and understand. Here are just a few:

Geography/topography

What area do you need to cover? What is the terrain like (flat, hilly, undulating, developed, rural, etc.)?

Number and type of users

- What terminals will users have (mobile/portable), and how will they use them (vehicle, indoor, outdoor)?
- How many functional groups can users be divided into, with how many users in each?
- How many RF channels/frequencies are available?

Target receiver

- What is the target receiver's antenna type and height?
- What is communicated over the network (voice or data)?

Confidence level

How confident can we be that the completed network meets its coverage goal? Coverage verification tests usually specify 99%, which means that if a coverage verification test was conducted 100 times, it would pass 99 times.

Coverage guarantee

To guarantee coverage, the coverage goal must be specified as area reliability. Coverage Verification Testing gives a specified confidence (usually 99%) that your network is delivering its specified area reliability, by randomly sampling the network's coverage across its service area.

Area reliability

Area reliability is the average across an area. Any network that is subject to a coverage guarantee (where the network vendor guarantees a certain level of coverage) should have its coverage specified as area reliability. There are two types of area reliability commonly specified:

- **Service area reliability**
  This is the average reliability over a defined service area. This service area could be political (such as a county), or operational (such as a 500m buffer around an electricity transmission network). If the service area reliability is 98%, there is a 98% chance that users anywhere in that area will have the desired level of service.
- **Covered area reliability**
  This the average reliability within the predicted coverage boundary. This might fall partially within, and partially outside the service area. For example if the covered area reliability is 98% and all we know is that a user is within the coverage boundary, they have a 98% chance of experiencing the desired level of service

Both definitions describe average reliability, but they do not describe how the network behaves at specific points. Some locations within the area may have very low reliability ("black spots"), but these are offset mathematically by locations with very high reliability.

Defining the edge of coverage

Radio waves get progressively weaker as they travel away from the transmitter. So there is a clearly-defined edge of acceptable coverage, between the radio network meeting requirements on one side, and falling short (however narrowly) on the other. The edge of coverage is defined by:

- quality – usually DAQ – mapped to an objective signal strength or bit error rate,
- contour reliability – how much of the coverage boundary must have the specified quality.

So, a radio network could be specified as “delivering DAQ3.4 with 95% reliability at the boundary”. On one side “Speech is understandable without repetition” (DAQ3.4) along more than 95% of the boundary, and fewer than 95% on the other side.

Multiple coverage needs

For some systems, it is insufficient to define uniform coverage requirements across your entire service area. Typically, there are areas of special consideration:

- critical use – prisons, courthouses, hospitals,
- high population density – urban areas, challenging terrain – mountains, canyons,
- challenging construction – significant buildings with “dead spots”.

Inbuilding coverage

- Identify where in-building coverage is needed. Include schools and colleges, hospitals, prisons, airports and any other critical buildings.

Want to know more? See Tait White Paper “Specifying, predicting and testing: Three steps to coverage confidence on your digital radio network.”