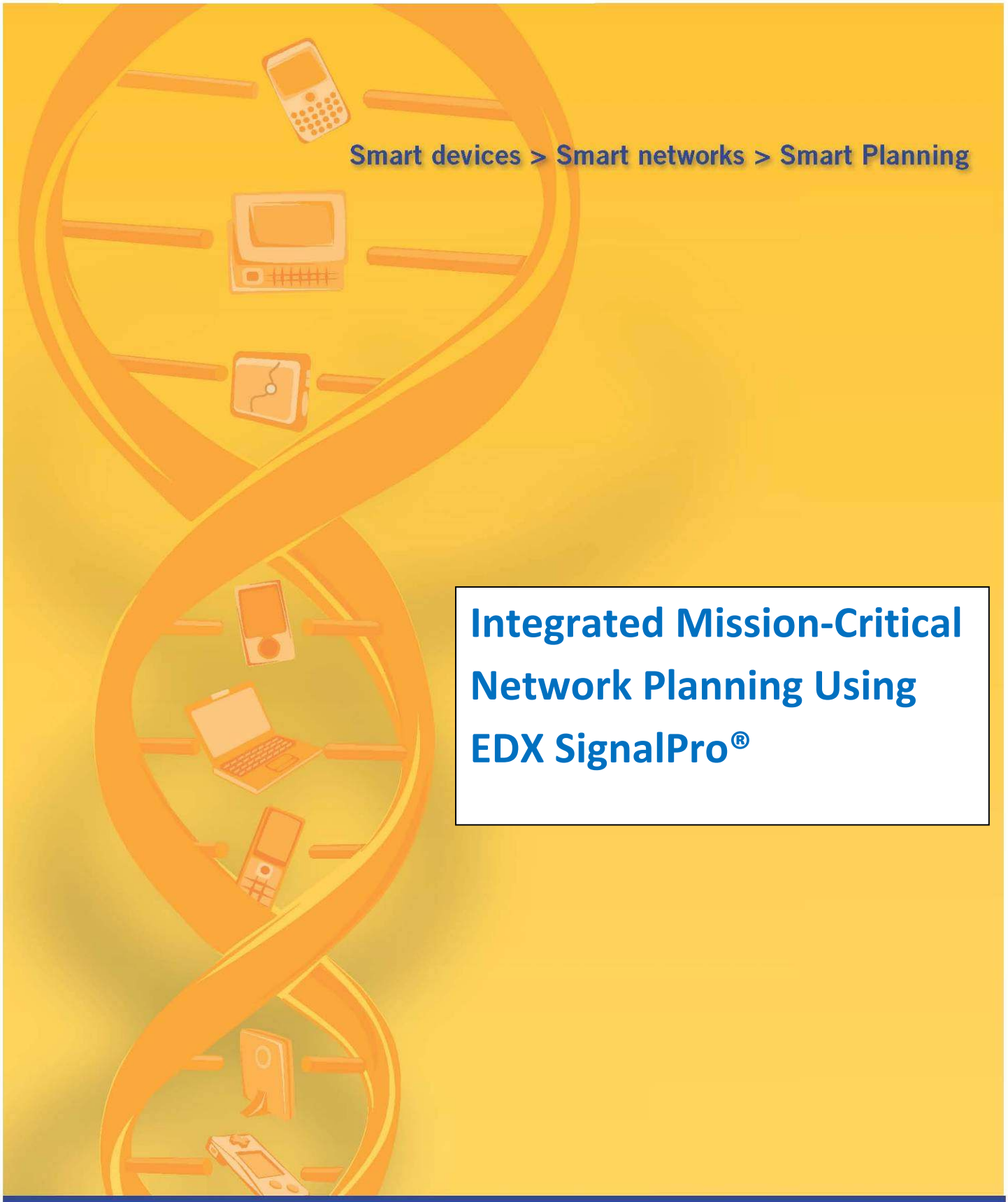

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Integrated Mission-Critical Network Planning Using EDX SignalPro®

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EDX WIRELESS

Integrated Mission-Critical Network Planning Using SignalPro®

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Overview

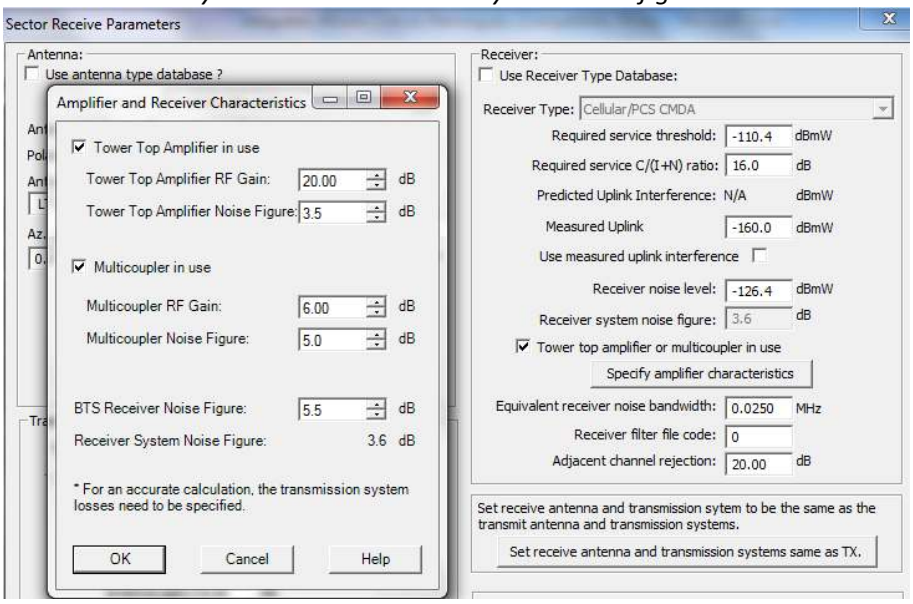
EDX® SignalPro® is widely considered to be the industry standard for mission-critical P25 and TETRA system planning for public safety and other applications. As such, SignalPro has met the challenges presented by the evolution of mission-critical radio systems beyond dispatch (PTT) to the systems of today that include high-speed wireless data using 700 MHz D-block LTE. 15 LTE-specific studies are available, including CQI, adaptive modulation data rate, FFR zones, ICIC capacity impact, system traffic and UE power level predictions using deterministic methods for downlink and stochastic or Monte Carlo methods for the uplink. With these capabilities, combined with a powerful automatic channel and PCI assignment tools, high-performance LTE systems can be easily planned and analyzed using SignalPro with the optional network design modules. Multiple systems that serve the same area can also be planned and analyzed in a common project, making it easy to design and visualize performance of P25/TETRA, LTE and backhaul (Multipoint) that are common to a mission-critical network.

P25 and TETRA Network Planning

Network designers today face the challenge of designing mission-critical radio networks with the ability to receive low-power transmissions from portable two-way radios, even those being used indoors. With its unique ability to simulate not only downlink (talk-out) but also uplink (talk-back) operation, SignalPro offers the following advantages in analyzing overall system performance:

- Independent uplink and downlink radio link analyses. This is useful for modeling situations where base station transmit and receive antennas are separate, common in land mobile radio (LMR) systems, especially in VHF.
- All basic studies (Coverage RSSI, Interference C/(I+N), BER, log-normal reliability, etc.) can be run both as downlink (talk-out) and uplink (talk-back) studies.
- Support for LMR-specific network topologies, including voting receivers and shared base station antenna systems.

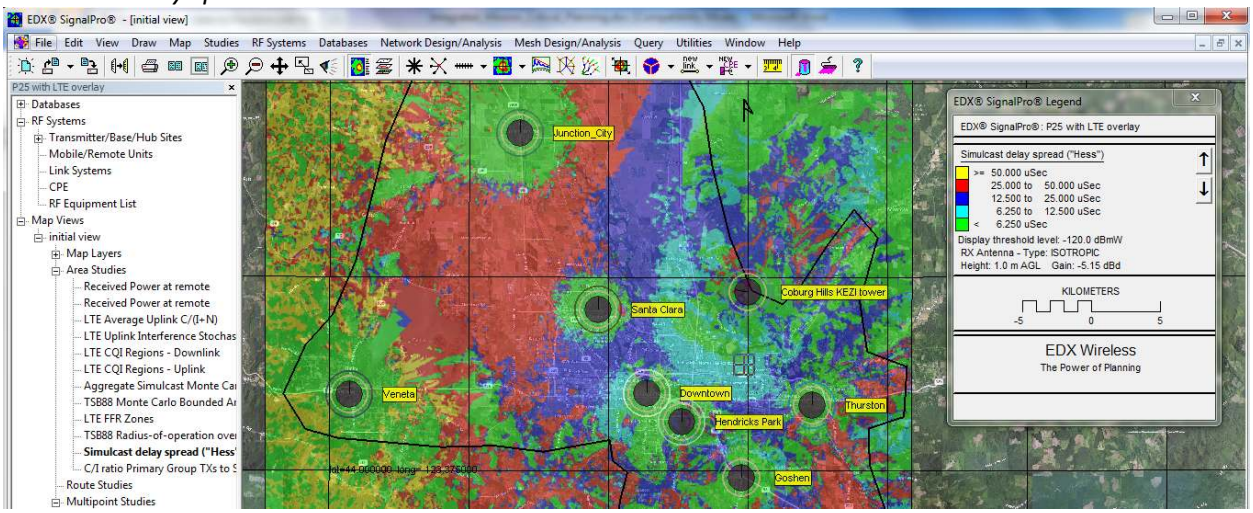
An example of the base station receiver parameters that can be specified in SignalPro is shown below. An optional dialog is available to specify tower-top amplifier and multicoupler parameters. This dialog will automatically calculate the receiver system noise figure.



Mission-critical radio systems contain many unique characteristics that need to be considered during the radio system design. These include, not only talk-out and talk-back coverage (signal strength), but simulcast delay spread, capture ratio, the impact on uplink performance from the use of voting receivers and detailed statistics of network reliability. Studies in SignalPro that are tailored for LMR system analysis include:

- Percent log-normal reliability
- Uplink percent log-normal reliability
- Uplink percent log-normal reliability using voting receivers
- Received power at best voting receiver from remote
- Simulcast RMS delay spread
- Maximum simulcast delay spread
- Number of servers within capture ratio
- Number of base receivers with power above threshold
- TIA/TSB-88 Monte Carlo studies. These are important for evaluating and ensuring P25 system performance during the development phase.
  Available TSB-88 Studies in SignalPro include:
  - TSB-88 Monte Carlo bounded area coverage
  - TSB-88 Radius-of-operation overlap reliability
  - Aggregate simulcast Monte Carlo reliability
  - Simulcast delay spread using Hess's calculation

An example SignalPro TSB-88 study plot of a UHF T-band P25 system in Eugene, Oregon showing the simulcast delay spread:



The study plot is shown overlaid on a Microsoft Bing aerial map, available in SignalPro.

SignalPro not only has a complete suite of analysis capabilities for mission-critical networks, but additional automated design capabilities are available in the optional design modules. These network design module capabilities include automated frequency planning (AFP) with support for separate uplink and downlink channel sets and custom channel pairs including non-standard frequency splits. The lists of available channels for AFP assignment can be customized for each base station, which is especially useful for sections of the network where certain channels cannot be used in one or more base stations due to licensing and coordination restrictions.

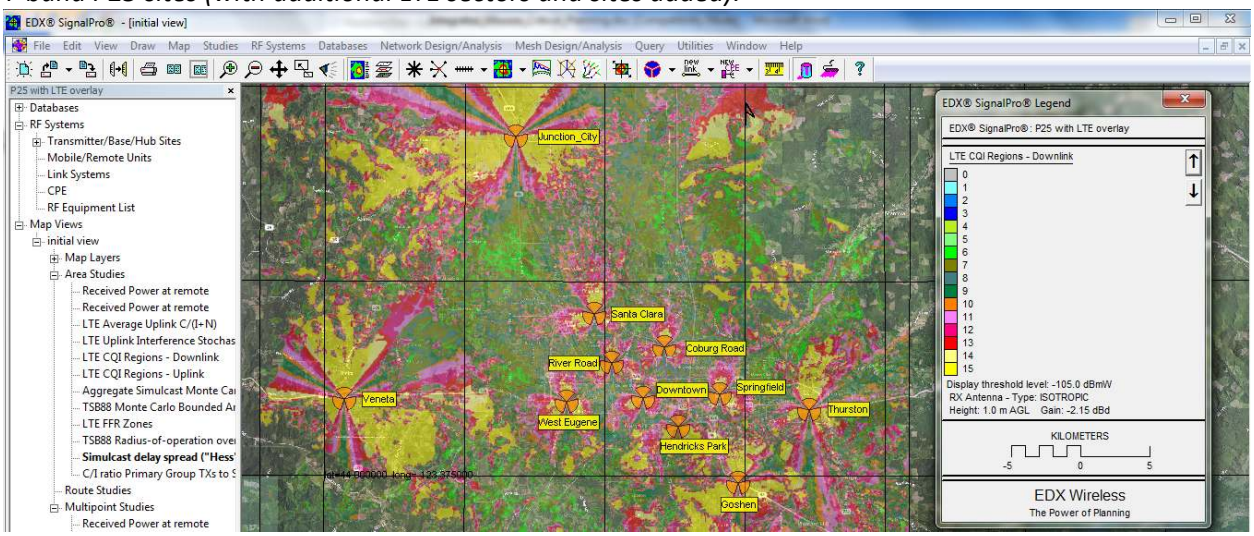
LTE Network Planning

SignalPro has the flexibility to support not only P25/TETRA dispatch network design , but with the LTE Module, has powerful network planning capabilities that have been used to design a number of mission-critical LTE systems. SignalPro with the LTE Module has the following design capabilities:

- AFP (automatic channel assignment)
- Automatic PCI (Physical Cell ID) assignment
- LTE Monte Carlo studies using flexible user-defined scenarios
- LTE packet-switched traffic model with support for both AM and UM RLC types.
- Support for special LTE system configurations, including:
    - FFR (Fractional Frequency Reuse)
    - UE's (mobile terminals) that don't support 64QAM on the uplink
    - Power control
- The following LTE studies are available with the LTE Module:
    - LTE Maximum Uplink C/(I+N)
    - LTE average uplink C/(I+N)
    - LTE interference for focus sector

- LTE OFDMA/SC-FDMA modulation regions – downlink & uplink
- LTE CQI regions – downlink & uplink
- LTE adaptive modulation downlink & uplink data rates
- UE power when using power control
- Inter-eNodeB handoff regions
- Inter-RAT (multi-system) handoff regions
- LTE FFR zones
- LTE average uplink CQI using Monte Carlo simulations
- LTE uplink interference statistics
- LTE number of ICIC (Inter-Cell Interference Coordination) suppressed interferers

An example downlink CQI regions plot of a Eugene, Oregon 700 MHz LTE system overlaid on existing UHF T-band P25 sites (with additional LTE sectors and sites added):

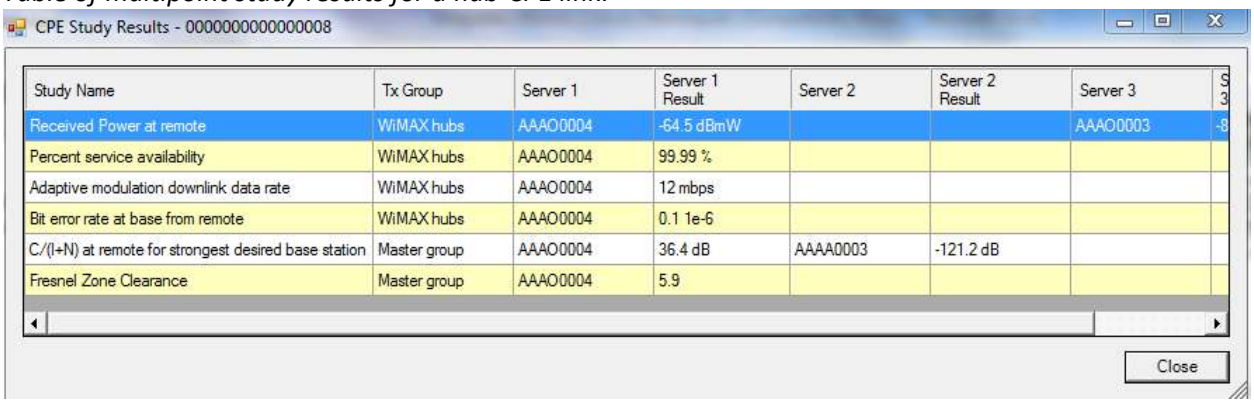


Backhaul (Point-to-Multipoint) Network Planning

Wireless backhaul is commonly used to connect base stations to the dispatch console or the core network. In SignalPro, backhaul networks can be modeled as point-to-multipoint systems, with the following features:

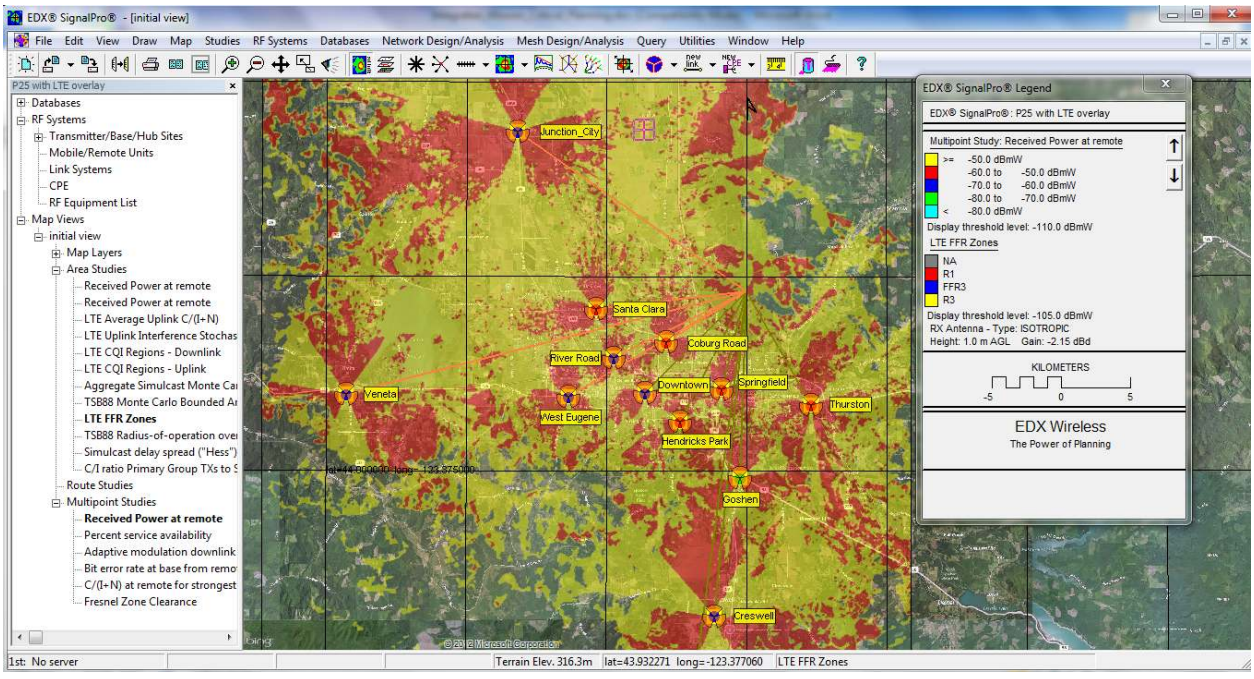
- Complete link characterization with median signal strength, availability, data rate, Fresnel zone clearance and other studies of each link.
- Additional link analyses are available with the optional Multipoint Module including uplink (reverse path), interference and data rate studies.
- Automatic serving hub and channel assignments with the optional Multipoint Module.
- Ability to display study results in thematic maps or tables.
- Displays link path from CPE to hub with link study details.

Table of multipoint study results for a hub-CPE link.



Integrated Mission-Critical Network Planning

SignalPro allows you to design, analyze and view multiple networks and display the results in one project map. The SignalPro map below shows an area study of the LTE Fractional Frequency Reuse (FFR) zones along with a thematic symbol on the collocated backhaul CPE's that represents the received signal level from the hub site. This LTE system was overlaid on an existing P25 T-band system. Various thematic study results and other map layers can be easily slected for display using the project pane on the left side of the screen.



Conclusion

As mission-critical networks evolve into complex multi-layered, multiband, multiple-technology systems, it becomes essential to use radio planning software with the power and flexibility to design and simulate networks using P25, TETRA, LTE, WiMAX technologies and multiple network topologies. EDX SignalPro is the ideal radio network design tool for planning all aspects of mission-critical networks.

About the Author

Steve Webster joined EDX in 2009 and is now Director of Sales Engineering. In this role, Mr. Webster brings his extensive engineering experience to the EDX sales team by working with EDX's customers to match the capabilities of EDX products to their wireless network planning requirements.
Mr. Webster has worked for 20 years in RF Engineering and Management roles in a variety of Wireless Industry organizations, including wireless carriers, consulting firms, site development firms, equipment vendors, and infrastructure (tower and DAS) providers in the US, Europe and Asia. Prior to working in the wireless industry, Steve worked in the 1980's for a university R&D lab developing complex radio network simulations for defense customers as well as for a large defense contractor to develop advanced communications electronic warfare systems.
Mr. Webster holds a BSEE from Clarkson University and an MSEE from Johns Hopkins University.

