TCI®

TCI Spectrum Surveyor®
Master the Spectrum for Greater Spectral Utilization and Higher Licensing Revenues

Traditionally, spectrum management has largely focused on static allocation; co-existence arrangements enforced through fixed geographic and spectral boundaries. Consequently, spectrum measurements are typically short-term ad hoc efforts to collect snapshots of incumbent spectrum usage in particular frequency bands.

Spectrum crunch brought on by new radio access technologies (wider instantaneous bandwidth, network densification, small cells, massive MIMO, low power transmitters) and use cases (wider coverage, mobility, hotspots, QoE, QoS) demand a dynamic approach to spectrum management.

TCI Spectrum Surveyor® leverages developments in distributed sensor technology (e.g. TCI 709/739) and advances in computing speeds, data storage capabilities, information management systems (e.g. Big Data) and service-oriented architecture to confront the spectrum management and scarcity challenge.

KEY FEATURES

› Data Driven Intelligence for Spectrum Management & Enforcement
› Networked or Stand-Alone Operation (for sensor nodes with limited connectivity)
› Task and Control network of monitoring sensors simultaneously (using groups) or individually
› Centralized Tasking and Measurement Results Database (TMRDB) facilitates Data Fusion and Analysis

› Built-In 3D Data Visualizations: Spectrum Occupancy, Field Strength, Coverage Maps and much more
› Automate routine spectrum monitoring tasks using Measurement Task Plans (MTP)
› Support for Data Analysis Tools: Power BI, Tableau, Qlik...etc.
› Compatible with TCI Spectrum Monitoring Systems
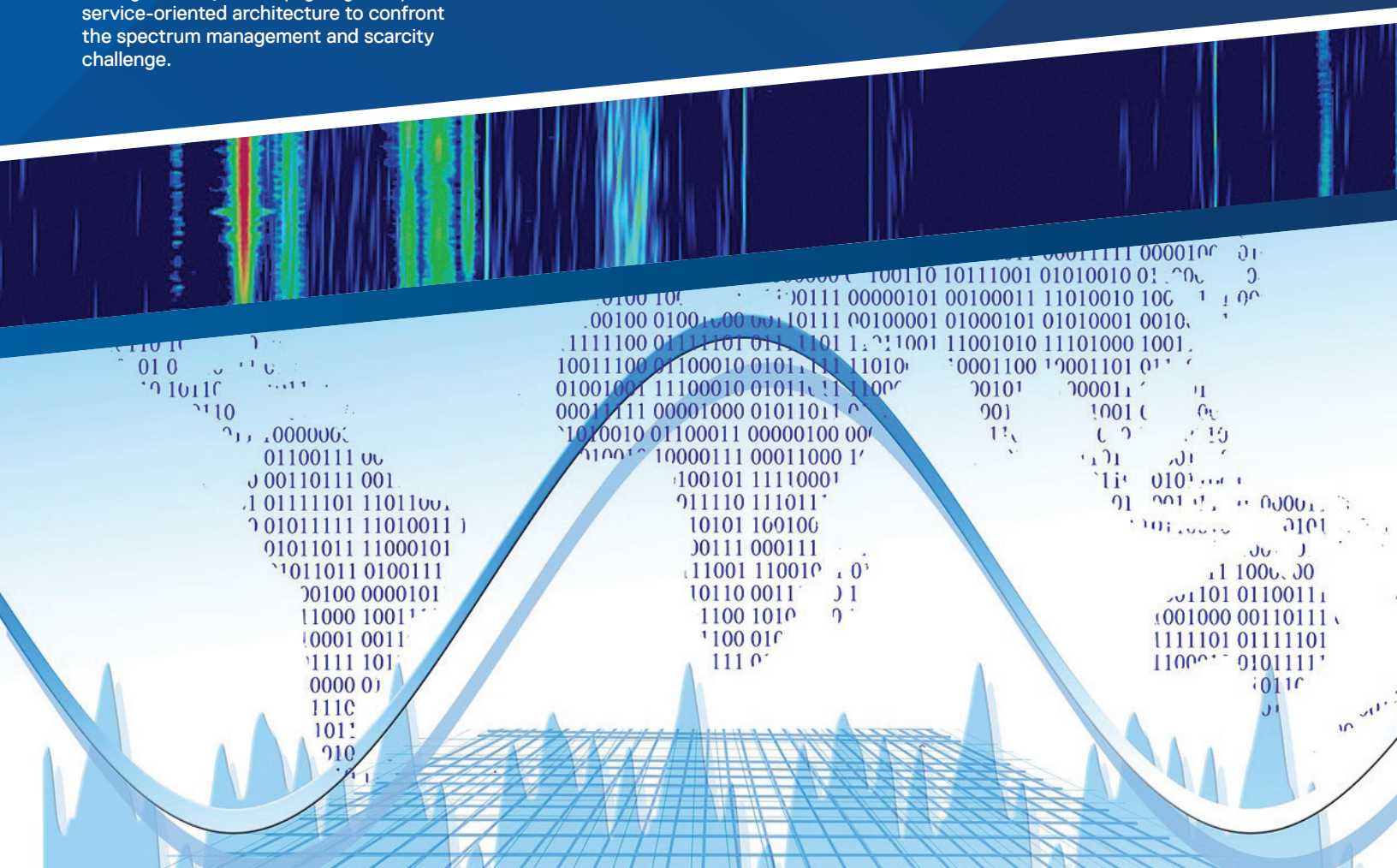
Smart Spectrum Assistant for Spectrum Analysis & Management

TCI Spectrum Surveyor®'s centralized data warehouse with built in analytics, visualizations and reporting enables users in assessing the available spectrum to answer the following questions:

1. Identify White Spaces by Frequency Band and/or Geographic Region.
2. Identify changes in the optimal use or uses of bands over Time.
3. Identify and Classify users- Licensed, Unlicensed, Primary vs. Secondary across frequency bands.
4. Identify frequency band that can be allocated to a secondary user.
5. Quantify differences in band occupancy at National, Regional, Local and Block level.

Spectrum Surveyor® Use Cases

Spectrum Management Goals	Spectrum Management Activities	TCI Spectrum Surveyor® Use Cases
Spectrum Assessment	Maximize Spectral Utilization. Support Emerging New Use Cases.	**Query White Spaces by Frequency Band, Space or Time:** • Identify and classify users: licensed, unlicensed or shared (primary vs. secondary) across frequency bands. • Identify changes in the optimal use or uses of bands over Time. • Identify White Spaces by Frequency Band. • Identify White Spaces by Geographic Region.
Spectrum Re-Farming and Reallocation	Coexistence Studies. Quantifying differences in band occupancy at National, Regional, Local and Block level. Geolocation Database.	**Automate routine monitoring tasks; Build Coverage Maps:** • Undertake measurement campaigns at National, Regional, Local & Block level employing a network of distributed sensors. • Automate Band Occupancy Studies using MTPs; capable of requesting measurement from several monitoring stations concurrently or individually. • Implement periodic measurements campaigns at predetermined intervals by grouping measurement stations into teams to build detailed geolocation based coverage maps.
Central Measurement Database	Collection of long-term measurement results from multiple sensors. Group measurement sensors into teams to facilitate same measurements across distributed monitoring sensors. Database status (connection) and automatic database notifications (customized alerts on database capacity). Export Measurement data using XML, CSV for data analytics.	**Data Collection, Fusion, Analysis, Visualization and Reporting to drive Actionable Intelligence:** • Create measurement tasks (sets of measurement to run) that can be assigned to any team of sensors. • Tasks can start immediately or at some time in the future. • Tasks can run continuously or be "time bound". • Query Measurement data (up to 10 million records) by Team, Task, and Sensor or by frequency, occupancy, field strength, time-of-day or day(s) of the week. • 2D and 3D visualizations of collected measurement data. • Visualize spectrum usage to see trends over long period and to identify whitespaces. • Data Migration feature to copy all data collected from any independent ("local") TCI system into the Central Database.

Monitoring with MTP

Fine-grained spectrum occupancy measurements require periodic and repetitive measurements carried out at different times in both space and frequency dimension. Each frequency band has different characteristics in terms of used bandwidth, channel spacing, channel access method, transmit power etc. that necessitate different measurement parameters for the frequency band of interest. TCI's Measurement Task Plans (MTP) and push button approach enables users to automate measurement campaigns for specific frequency band/s and to schedule measurements at predefined intervals or at specific times.

MTPs also enables users to schedule measurement campaigns concurrently on a network of monitoring sensors; each sensor running the same measurement or tasked separately depending on their location or group association.
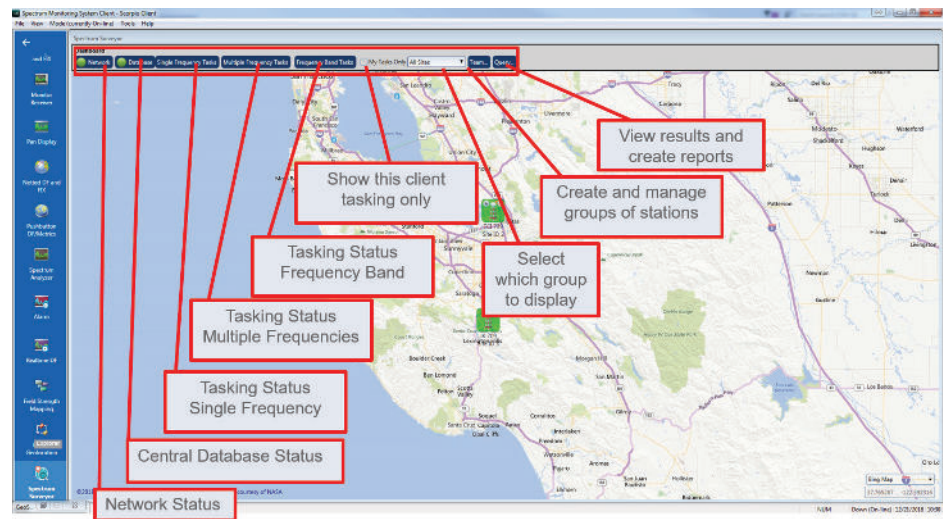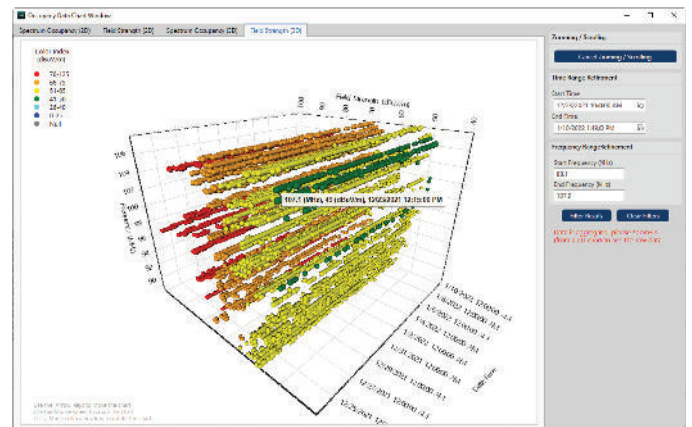

> Spectrum Surveyor® Dashboard

Data Collection, Fusion & Integration:

TCI Spectrum Surveyor® offers a unified database to integrate measurement task plans (MTPs) and accompanying spectrum measurement data from a network of distributed sensors. The ability to handle voluminous data in a centralized database enables data fusion, analysis and sharing across the organization.

Data Analytics & Visualizations:

TCI Spectrum Surveyor® with advanced data analysis enables spectrum regulators and administrators to identify and determine the extent and source of interference. 3D Visualizations allow unprecedented ease of use in fine-grained analysis of spectrum utilization by region and spectrum occupancy by frequency band/s. Users can filter spectrum measurement results by frequency, field strength, occupancy, individual stations (or team of stations), task, date/time, time-of-day, or day(s) of the week.

> Data Visualizations

Spectrum Surveyor®: Data Integration, Analysis & Visualization for Actionable Intelligence

TCI Spectrum Surveyor®'s powerful data analytics and visualizations enable users to undertake spectrum monitoring-enforcement goals by leveraging data driven intelligence. The goal of attaining higher spectral utilization and associated licensing revenue is easily achievable with TCI Spectrum Surveyor®.
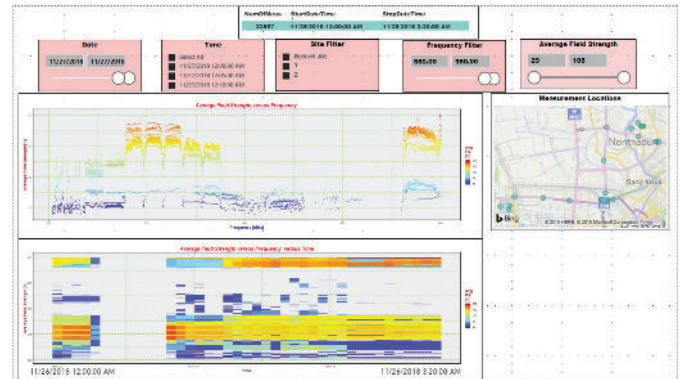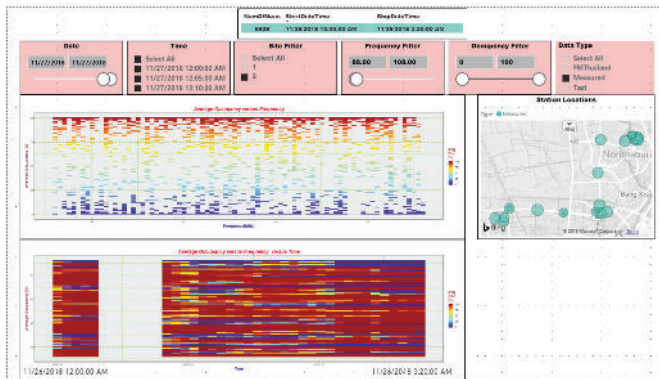
> › Custom Visualizations

TCI Spectrum Surveyor® Requirements

- Windows Server 2022 Standard Edition Operating system and license
- SQL Server 2019 Enterprise Edition software and license
- TCI Spectrum Surveyor® Database Maintenance software
- TCI Scorpio Client software and license

Microsoft® SQL Database Server (On Premise) Hardware Requirements*

- Memory: > 64 GB DDR4
- Processor Speed Minimum: > 2.0 GHz
- Processor: Intel Xeon Silver 4215 2.5G, 8C/16T, 9.6GT/s, 11M Cache, Turbo, HT or higher
- Hard Disk Drive: 2TB or higher
- Storage: 20 TB HDD (typical)
- Power Supply: Dual Redundant Power Supply
- I/O Ports: 4 x 1Gbe Ports, 6 x USB 3.0, 1 x VGA, 1 x Serial Port
- Drives: 1 x CD-DVD-RW (double layer)

Note: System Requirements are subject to change based on the intended use case and data volume.

TCI®

TCI INTERNATIONAL , INC. 3541 Gateway Blvd., Fremont, CA 94538-6585 USA
TEL: 1-510-687-6100 | FAX: 1-510-687-6101 | USA: 1-800-824-8074 | **www.tcibr.com**

ISO 9001:2015 CERTIFIED