NOKIA

Nokia Interference Mitigation

White paper

Contents

Background

Microwave radio systems have been in commercial use within the U.S.A. since the early 1950's. Interference into licensed microwave radios has always been a possibility however the Federal Communications Commission (FCC) rules outlining the use of microwave radio equipment ensured the probability of occurring was very low. With the recent FCC rule changes allowing unlicensed WiFi devices into the 6 GHz (5.925 – 6.875 GHz) band, operators must become more vigilant in the identification of interference events.

The FCC will under certain conditions allow unlicensed devices into the 6 GHz band, however the microwave radio services or as referred to by the FCC as Fixed Services maintain primary status. In simple terms, the licensed Fixed Services shall not receive harmful interference from other devices. If an unlicensed device interferes with your Fixed Services, you have the rule of law to cease the cause of the interference.

Now that you understand your rights guaranteed by the FCC, how do you detect or infer that there is interference impacting your microwave radio link? Nokia has been at the forefront to develop proactive tools and reports that allow you to monitor your Nokia Wavence network for interference. The Nokia Network Services Platform (NSP) and TSM-8000, provide a broad view of performance measurements, statistics, alarms and status indicators to keep the Operator apprised of the Wavence network performance. Nokia has also developed the Wavence Spectrum Analyzer tool that allows operators to use the best piece of test equipment for seeing the interferer, that being the Wavence radio itself. The following sections of this document present Nokia's Network Management System solutions the TSM-8000 and Network Services Platform and the Nokia Wavence Spectrum Analyzer Tool (WSAT). We conclude this document with instructions on how to communicate your interference case to the FCC Enforcement Bureau's Spectrum Enforcement Division.
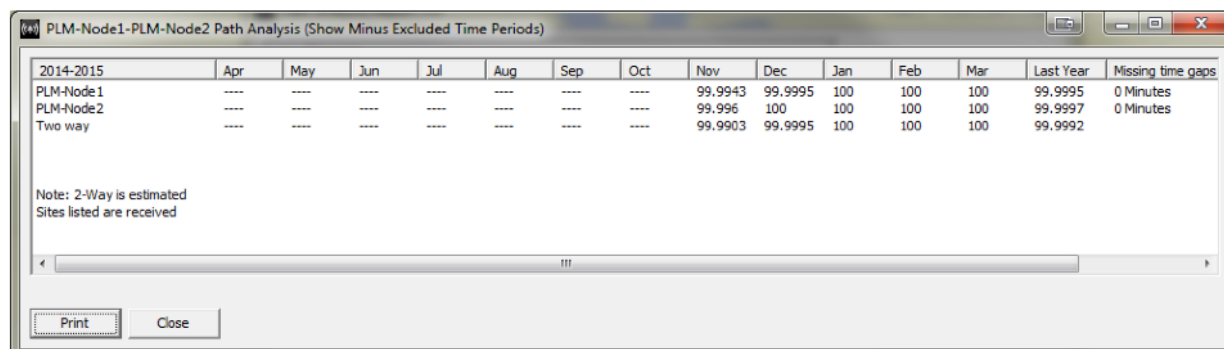
Network Management Solutions

TSM-8000

The Nokia TSM-8000 provides highly reliable fault management and control of your Wavence or Legacy Nokia microwave radio network. The TSM-8000 is a graphically oriented element management system. It is scalable through software keys to support small, medium, or large Nokia microwave radio networks of up to 1024 Network Elements. The TSM-8000 supports multiple users, multiple networks and multiple protocols. It automatically collects and stores alarm, status and performance data from the monitored transmission system equipment. This information is displayed both graphically and textually. The TSM-8000 also provides comprehensive reports for all current and historical activity for the entire network including all operator actions.

The TSM-8000 is a network management platform that focuses on microwave networks and specifically fault and performance reporting.   With the flexible scheduled reports that can be automated to send to a file server or email, the TSM-8000 has been the tool to set the standard in proactive management of Microwave networks.

With the introduction of WiFi 6 devices into the 6 GHz band, proactive monitoring of possible interference is within the scope of the TSM-8000. The approach the TSM-8000 has adopted to isolate long term and repetitive interference on a per link basis is via a dedicated report. This report will provide a list of links that have met certain criteria that would indicate that the path has seen some level of interference. These criteria are link performance information such as the standard received signal level data, G.826

performance data, Mean Squared Error rate, and adaptive modulation counters (if applicable).

Additionally, the TSM-8000 has long supported path availability reporting. This report is based on receiver alarms and unavailable seconds and will allow the customer to quickly see if the path availability is meeting the design criteria.

Other tools the TSM-8000 includes to assist customers in identifying possible links with interference are:

- On demand performance charts: allows customer to overlay radio parameters such as modulation and receive signal level (RSL) on a single chart.

- Adaptive Modulation PM chart: 15 minute and 24-hour modulation levels

- RSL and TSL PM chart: 15 minute and 24-hour min/max/average transmit and receive level

- RSL History log download: TSM-8000 can automatically download the RSL history log and append each file, removing any overlapping data. This log file will provide a finer detail of quick changes to the Mean Square Error (MSE) and RSL values that could happen in cases of interference.

The TSM-8000 is a graphically oriented alarm monitoring and fault management system appropriate for small to large Nokia microwave radio networks. It is Microsoft Windows® based and operators quickly come up to speed on its operation with the easy to read display and point and click operation.

Network Services Platform (NSP)

Network Services Platform (NSP) is the network management system and SDN controller for the whole Nokia transport portfolio. It provides end-to-end management tools to deal with a multi-technology (microwave, IP and optics) transport domain in a homogenous and streamlined manner. Whenever technology-specific aspects need to be addressed, such as interference, the NSP can utilize the visualization, correlation, storage and automation capabilities to provide to the user the needed information.

Fault management and network supervision

A comprehensive set of applications can be used to inspect the network operative state and the events that are occurring.

The Wavence network status is represented at a glance by NSP dashboard, an entry point for the user to spot network health issues and further investigate via navigations to more focused applications.
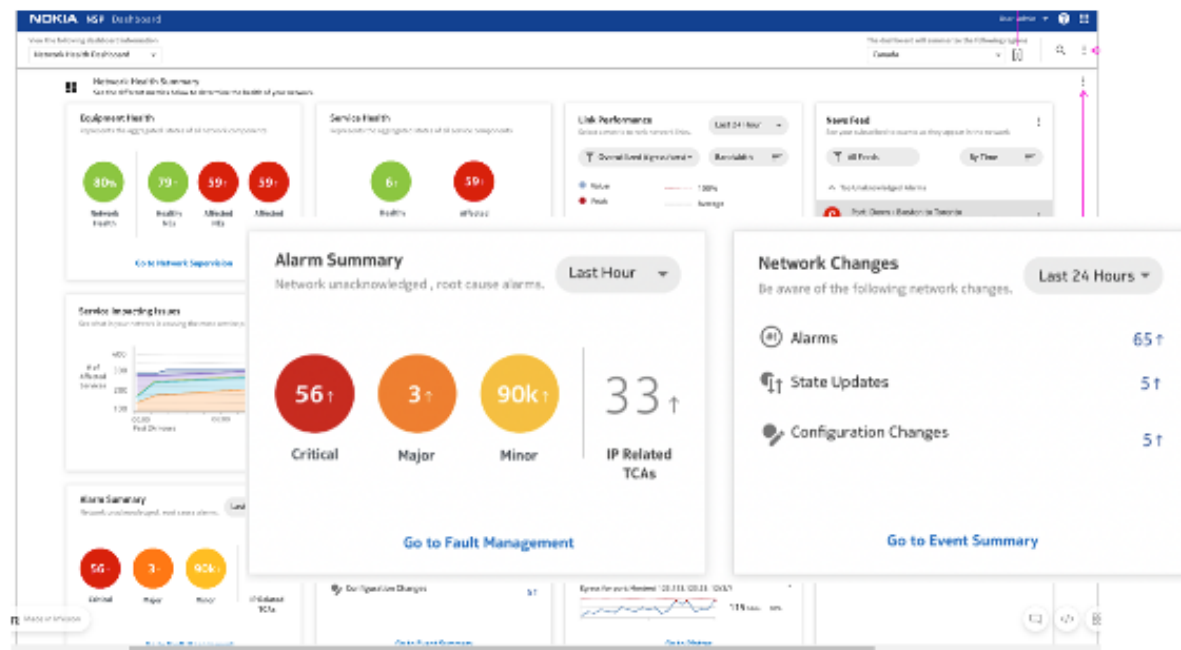
Via NSP applications, the microwave domain can be visualized from a topological and network element status perspective, providing an overall network health summary.
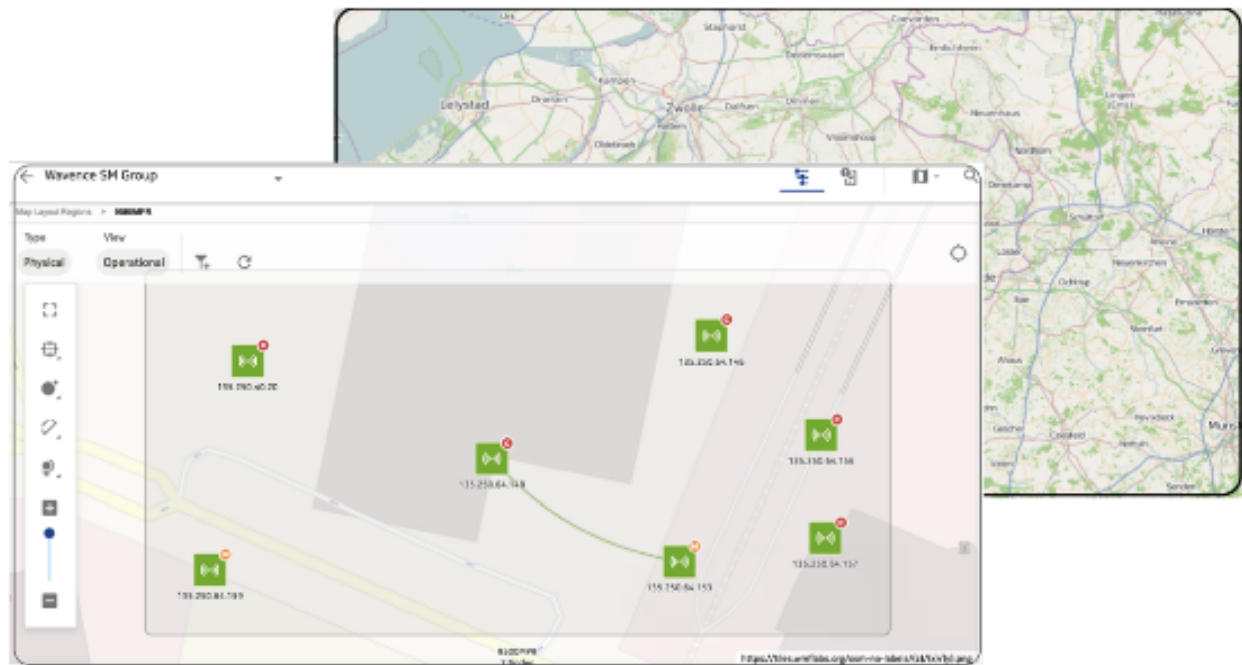
Events and faults are summarized and shown in a prioritized manner

Specific correlation and aggregation functions are available to understand the way events relate one another in terms of root causes and impact.
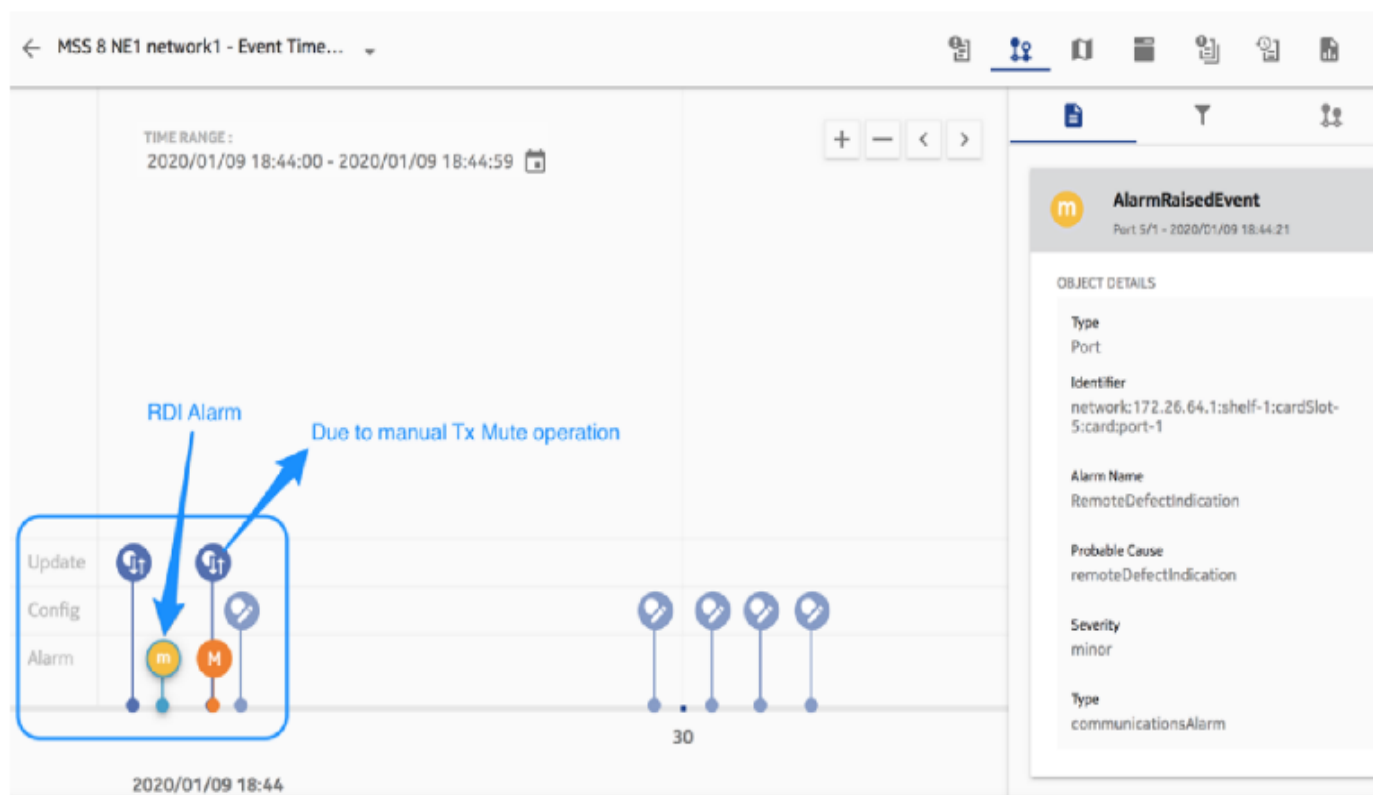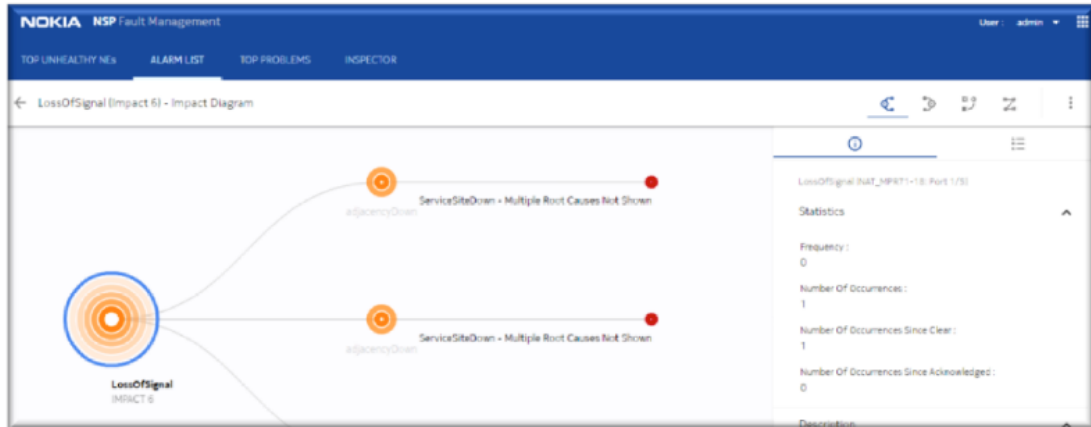
Analytics

The NSP Analytics function provides applications tools to allow the user to examine the network for Key Performance Indicators (KPI). From a platform standpoint, the scalability and reliability of the analytics framework is an aspect that is typically overlooked but fundamental to operate large transport networks.

NSP Analytics offers high availability and redundancy for collection and retention of data. Stored data is accessed by specialized reports designed to assist the user in trouble-shooting activities.

The Link budget report observes changes in the receive signal level (RSL). RSL values taken from design documents and measured at the time of installation of the link can be inserted into the tool and used as a reference to detect any deviation taking place. The amount of deviation in dB from the design value can be selected by the user and the system will record the number of times the actual value deviated by the number of dB selected. Propagation impairments can be identified efficiently, excluding those cases from an interference scenario.

	1+0 and 1+1						
Link Name	Link Distance(km)	Site ID	Port	Design RSL (dBm)	Installed RSL (dBm)	Actual RSL (dBm)	Number of Deviations
Node_D(Port 3/1)-Node_C(Port 4/1)	12.83						
		172.26.66.28	Port 3/1	-53.5	-51.2	-99.0	114
		172.26.66.27	Port 4/1	-53.3	-96.8	-99.0	114
Node_C(Port 1/1)-Node_A(Port 4/1)	31.8						
		172.26.66.27	Port 1/1	-44.3	-42.2	-42.0	0
		172.26.66.25	Port 4/1	-47.5	-43.4	-42.0	114
NE2 AREA A(Port 3/5)-NE1 AREA A(Port 3/5)	34.63						
		135.238.236.163	Port 3/5	-31.0	-30.8	-99.0	113
		135.238.236.162	Port 3/5	-32.0	-31.4	-99.0	114

Report configuration panel:

* Start date: DAY-1
* End date: DAY
* Actual vs Design threshold (dB): 5
* Actual vs Install threshold (dB): 10
* Number of Deviations: 5
* Granularity: 15 Minutes
* Distance Unit: Kilometer
* Show report output on one page

Whenever the link availability is concerned, the Link Unavailability report provides a view of this performance indicator with a timetable showing the amount of time a link has been unavailable.
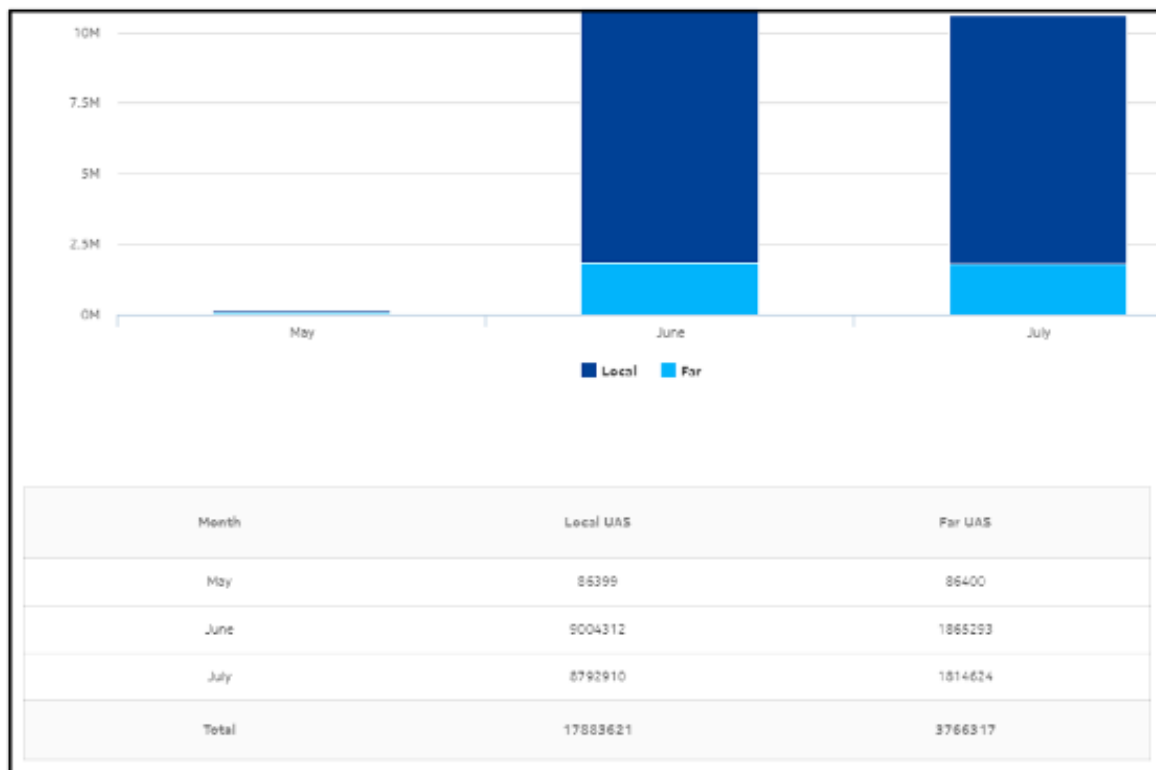
Link Unavailability Summary

| Start Date: | 2020-08-31 23:59:59 IST | | End Date: | 2020-09-10 20:00:47 IST |
| Report Date: | 2020-09-10 20:00:47 IST | | | |

1+0/1+1/2+0/2+2

Link Name	Link Distance(km)	Site ID	Port	Unavailable Seconds
Radio-Node_B|Port B/3|-Radio-Node_A|Port 3/3|	136.57219			
		133.238.236.178	Port 4/3-Channel 1A	139
		133.238.236.178	Port 3/3-Channel 1B	351674
			Total Unavailable Seconds	351813
UBT80LOW|Port 3/5|-UBT80HIGH|Port 3/5|	8525.0293			
		133.238.236.169	Port 3/5	49782
		133.238.236.170	Port 3/5	430
			Total Unavailable Seconds	50212

| Month	Local UAS	Far UAS
May	86399	86400
June	9004312	1865293
July	8792910	1814624
Total	17883621	3766317

For a global link performance observation, the Radio Performance report gives at a glance a parallel view of the G.826, adaptive modulation and received signal level trends. This report is perfect for identifying interference dynamics such as verifying the way link quality and adaptive modulation parameters are affected while the RSL statistics are stable.
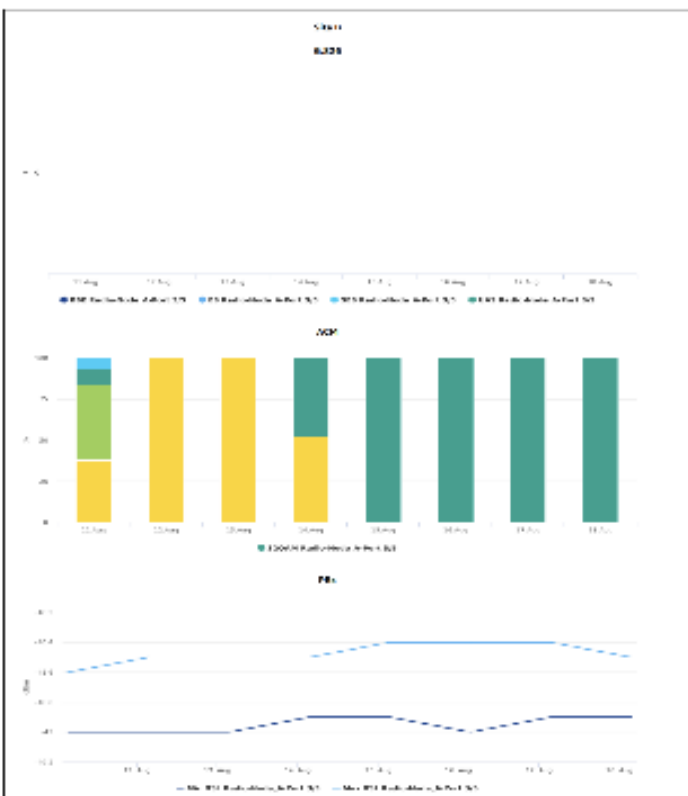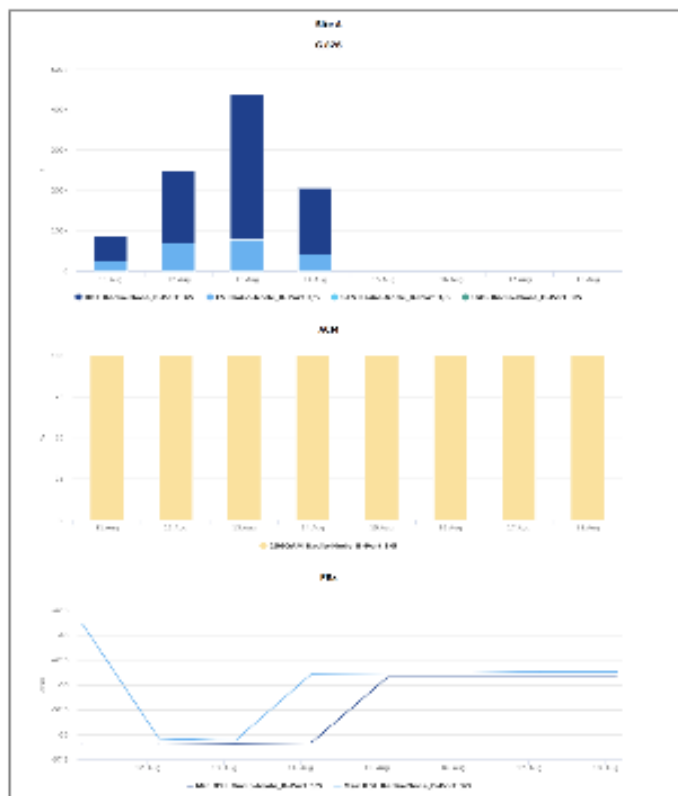
Throughput and Utilization values highlighted in red indicates no data

| Date	RSL (dBm)	Min RSL(dBm)	Max RSL(dBm)	Highest QAM	Lowest QAM	BBE (s)	ES (s)	SES (s)	UAS (s)	TDF(#)	Throughput(Mbps)	Utilization (%)
2023-08-11	-48.9	-55.8	-48.9	256	256	61153	25495	0	47	0	0.0	0.0
2023-08-12	-55.6	-55.8	-55.4	256	256	178714	69510	0	0	0	0.0	0.0
2023-08-13	-55.6	-55.9	-55.6	256	256	360664	79091	0	0	0	0.0	0.0
2023-08-14	-52.4	-55.8	-48.9	256	256	162798	47874	0	0	0	0.0	0.0
2023-08-15	-48.9	-49.2	-48.8	256	256	0	0	0	0	0	0.0	0.0
2023-08-16	-48.9	-49.2	-48.8	256	256	0	0	0	0	0	0.0	0.0
2023-08-17	-48.9	-49.2	-48.7	256	256	0	0	0	0	0	0.0	0.0
2023-08-18	-48.9	-49.2	-48.7	256	256	0	0	0	0	0	0.0	0.0

The radio performance reports can be complemented by Real-time Analytics for a more focused KPI analysis looking at trends, gaps and baseline deviation. Via baselining, a specific KPI for a given period can be sampled as a reference for comparison with future trends, representing the effect of an interference taking place.
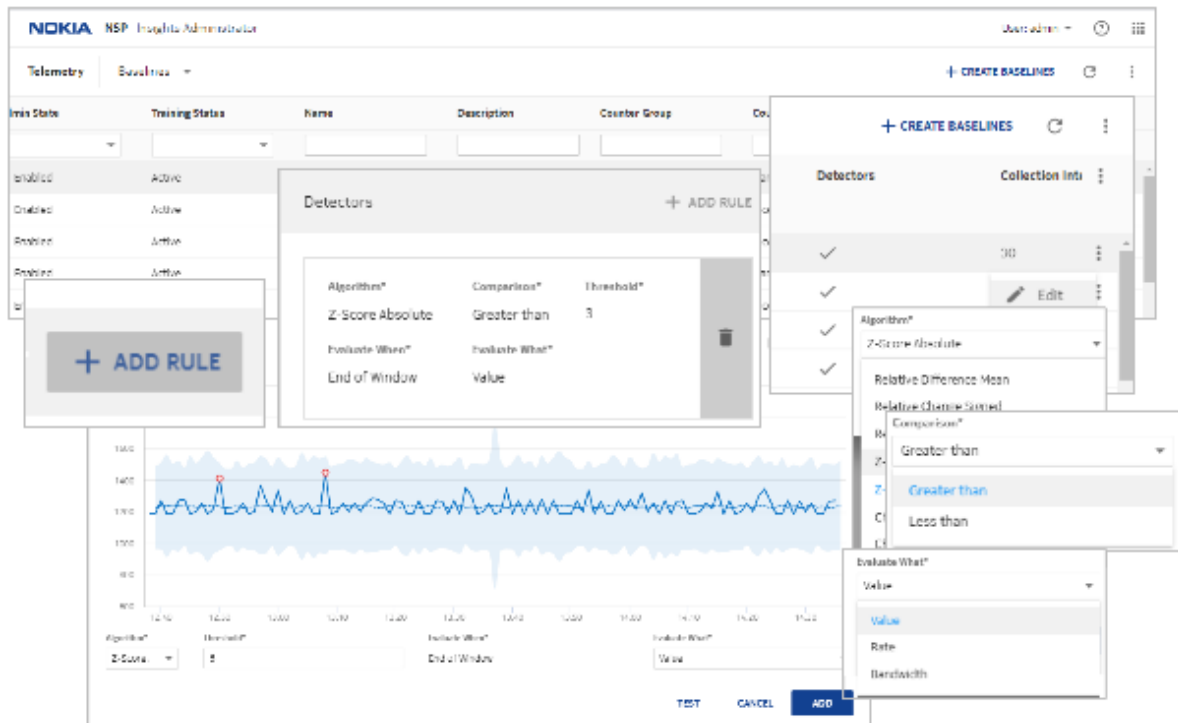
Automation and interference detection

Network operations base their foundation on manual processes specified in the operation guidelines. Interference troubleshooting represents one of those processes where the operator follows a set of steps to narrow down the radio link behavior to a probable interference scenario.

This manual operation has several limitations as it cannot scale and requires an on-demand engineering analysis. NSP has an automation framework called Workflow Manager conceived to replace manual operations with automated ones. Its programmable platform provides a short delivery lifecycle to keep the automated processes up to date and tailored based on the customer specific need.
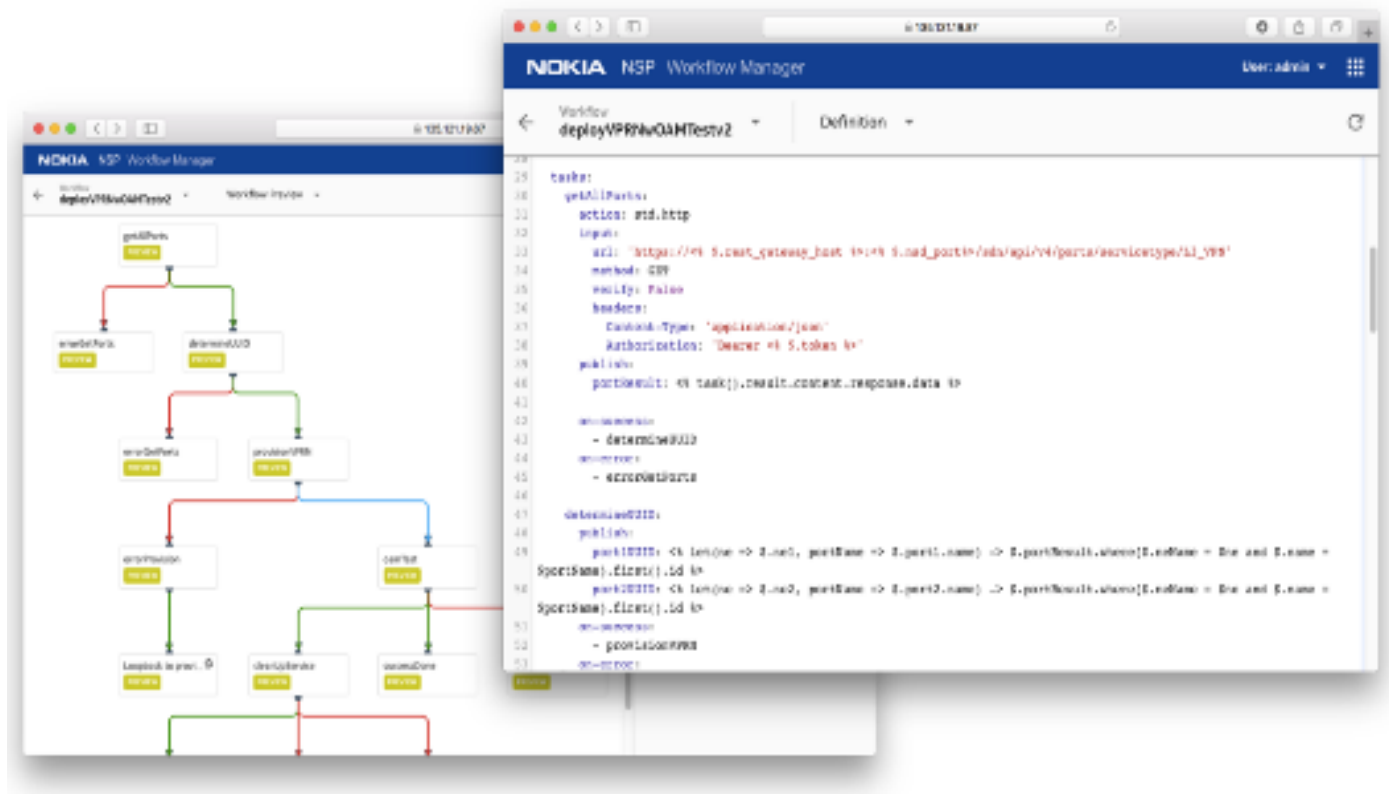
To deal with interference, the automation process is triggered by a KPI degradation that could represent an interference case or not. Once the process is started, it goes through a set of steps (similar to the ones that typically are followed by manual operations) to verify the system configuration, operational status, faults and other microwave KPIs. At the end of the workflow, the probable interference is confirmed or excluded depending on the results of the interference pattern analysis.

Spectrum Analyzer tool

What is the Nokia Wavence Spectrum Analyzer Tool (WSAT)?

The Nokia Wavence Spectrum Analyzer Tool (WSAT) is a software program that allows users to use the Nokia Wavence Transceivers as a spectrum analyzer. The Nokia Wavence Transceivers include a low power receiver detector that allows a greater range for detecting low receiver power levels. When used with the Nokia WSAT software, the Nokia Wavence Transceivers provide a better range to detect potential interfering signals than many expensive and bulky spectrum analyzers. The receiver sensitivity of the Nokia Wavence Transceivers is in the range of -100dBm, which is typically 25 to 30 dB better performance than what commercial spectrum analyzers provide. Therefore, the Nokia Wavence transceiver is an excellent device for measuring in band interference without the need to spend several thousands of dollars for a separate spectrum analyzer.

The Nokia WSAT software runs on standard Microsoft Windows and requires nothing more than a standard web browser to provide spectrum scanning and analysis.

How It Works

The Nokia WSAT is a free-standing application requiring nothing more than a standard Microsoft Windows computer. The Nokia WSAT supports transceivers connected to the Wavence Microwave Service Switch (MSS) or the 7705 SAR as well as transceivers that are deployed in stand-alone mode without an indoor unit. To properly utilize this tool the far end transmitter of the radio receiver you are connected to must be muted in order to allow the underlying interferer to be visible to the WSAT program. Thus, this is an out of service measurement.
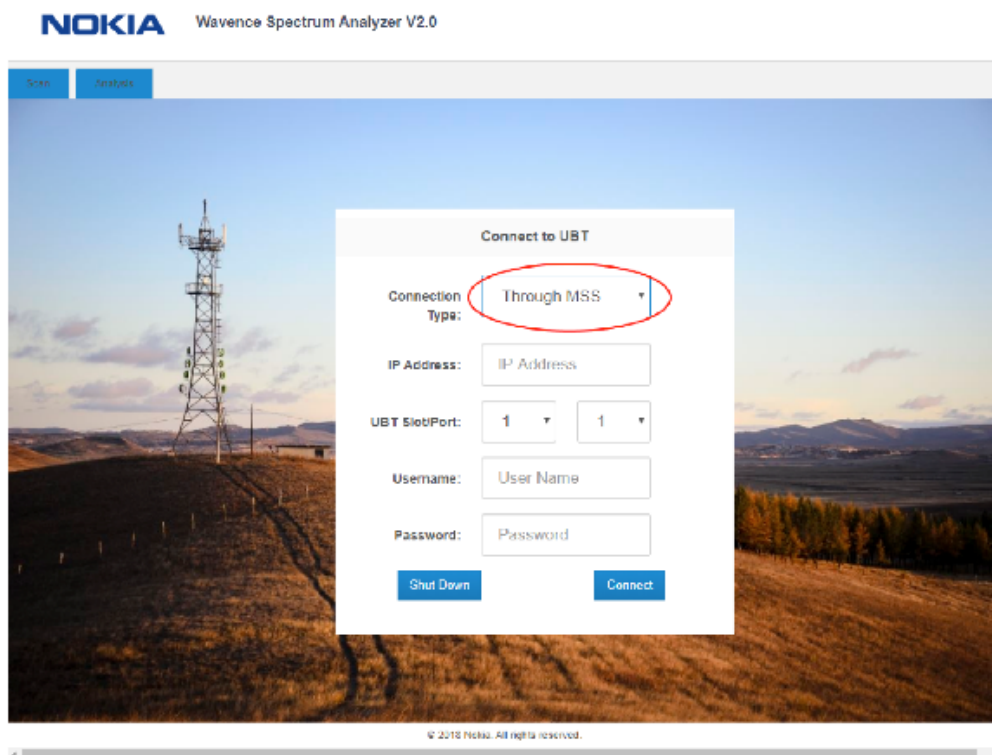
After selecting the connection type users can then make specific adjustments to the scanning frequency range, the duration of each step and other parameters.   These parameters allow customers to do a quick, wide scan of the entire band and then fine tune the scan down to a short range to validate the possible interference.

When the user starts the scan, the Nokia WSAT software will automatically record the data received from the Nokia Wavence transceiver. During the scan the user is updated with a chart showing the signal levels from the transceiver.
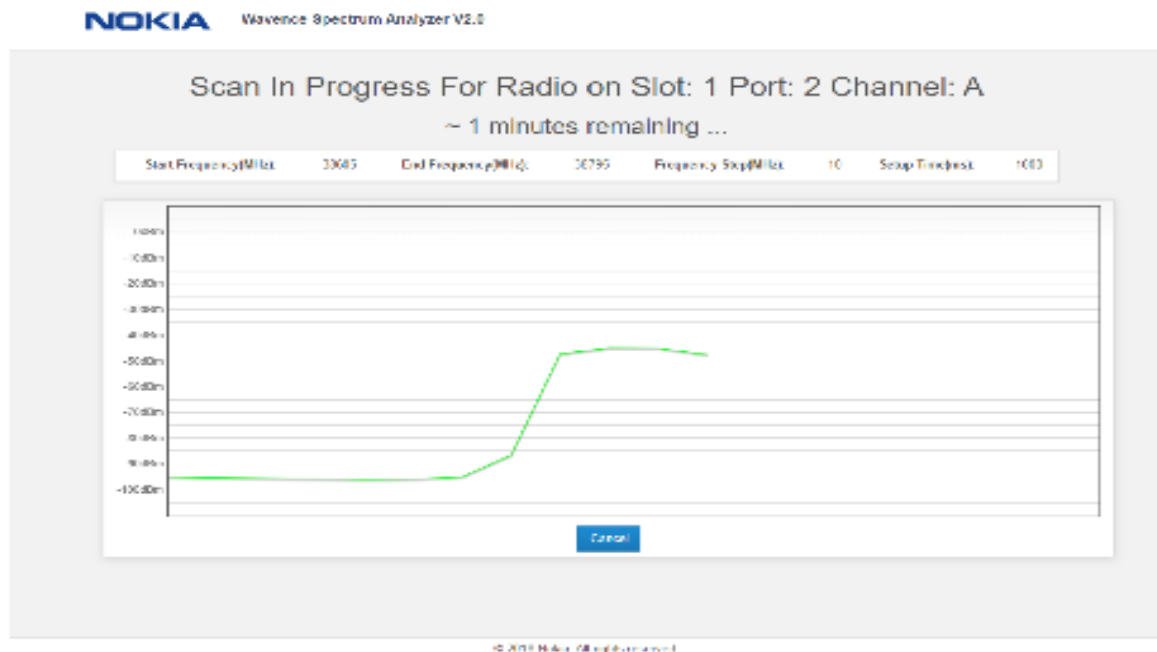
The Nokia WSAT software will show the user that a scan is in progress and when the scan has been completed. The user will have the ability to save the data as CSV file for later analysis.
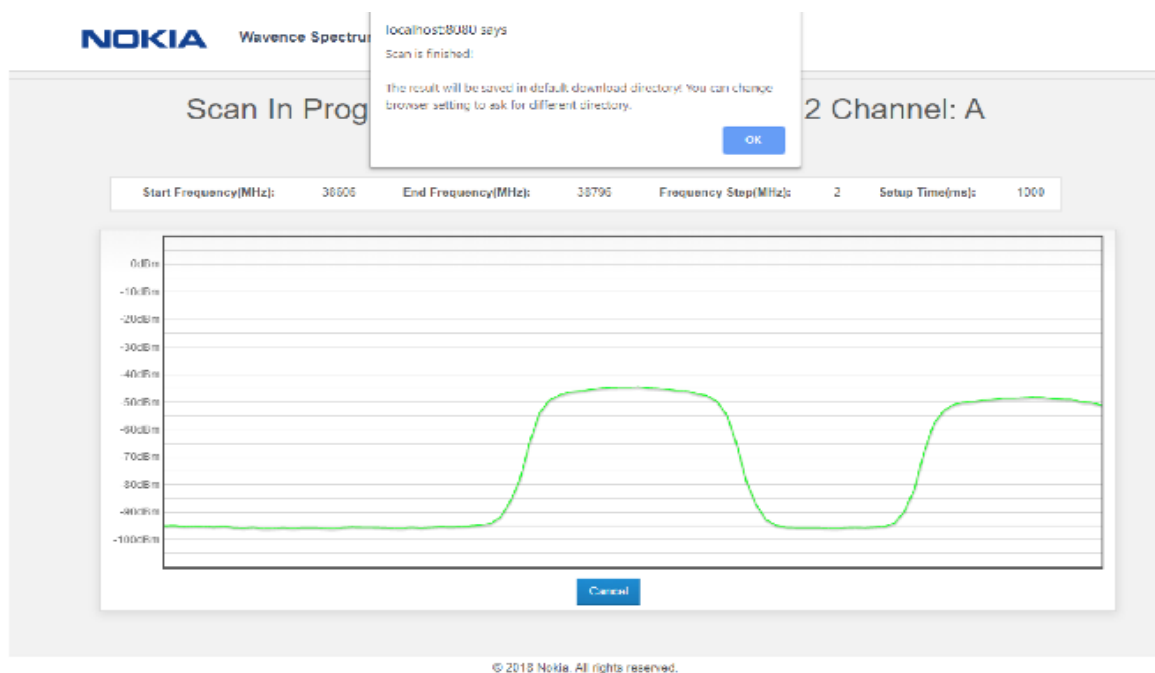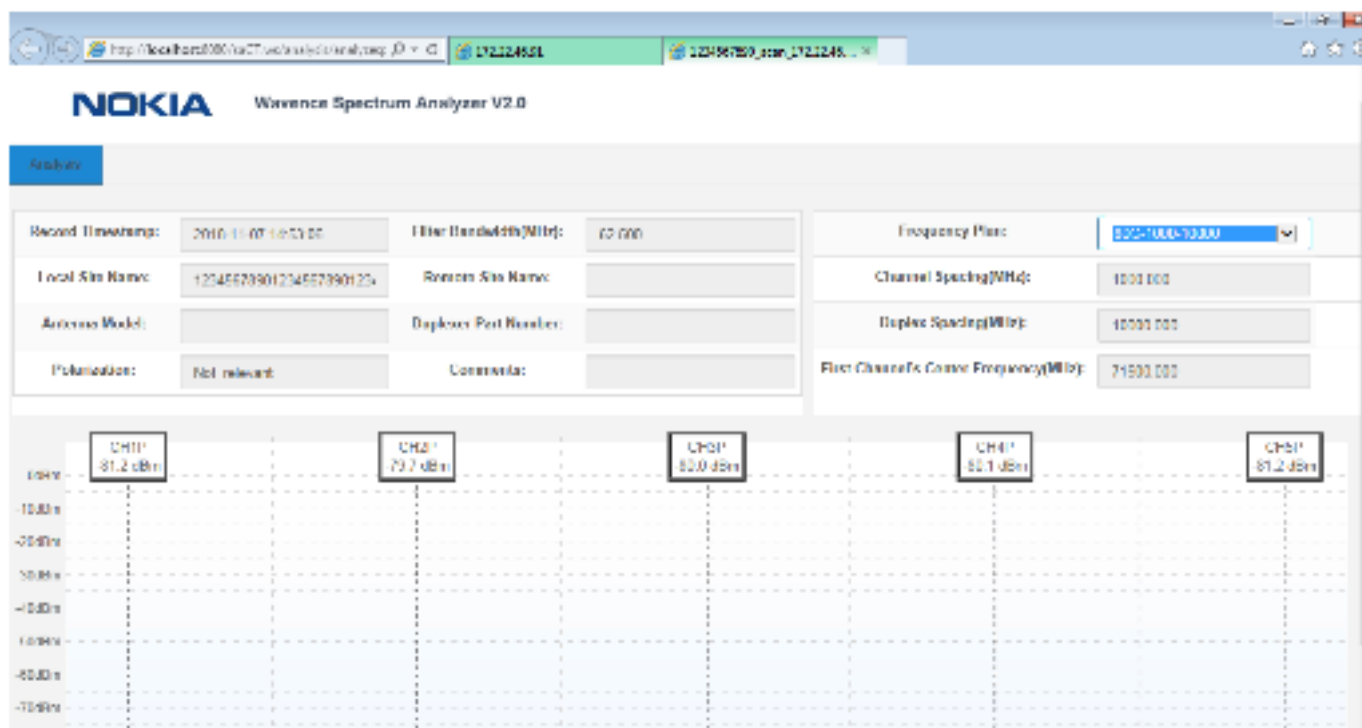
What it Produces

The completed scan creates a CSV file that can be opened in the Nokia WSAT tool to produce spectrum vs frequency channel charts. The CSV file allows the user to search the data for higher than expected values when the other end of the link is muted or turned off. This would indicate some level of interference on the link.

The Analyze function of the Nokia WSAT can be accomplished offline to provide flexibility for the customers and to minimize any service disruptions.

You see what appears to be interference. What next?

Your Nokia TSM-8000 or NSP has presented information that leads you to suspect your Fixed Service link may be experiencing interference. Using the Nokia WSAT software you confirm that there is an interferer visible. What now?

Unfortunately the burden of isolating the source of the interference falls to you the operator. Actions such as using a spectrum analyzer with a horn antenna to physically isolate the source or hiring the appropriate technical resources may be required. The source of the interference is anticipated to be close to the Fixed Service location. Once the source is determined the operator should attempt to resolve the issue locally. This will prove to be the more expeditious path to resolution compared to involving the FCC. If the attempt to resolve locally is unsuccessful, then involve the FCC Enforcement Bureau's Spectrum Enforcement Division. This is the organization responsible for resolving your interference issue. There are several key items of information that will aid the FCC in addressing your case.

The call sign and address of the station experiencing the interference;
The telephone number of a contact person for the station;
The frequency on which the complaining station operates;
A detailed description of the nature of the interference, including the duration and frequency of the occurrence of interference;
The owner and contact information for the source of the alleged interference;
The frequency on which the alleged interfering facility operates;
The provision of the Commission rule believed to have been violated by the alleged source of the interference. Those rules are shown below:

- CFR 47 Part 15.5 (b) Operation of an intentional, unintentional, or incidental radiator is subject to the conditions that no harmful interference is caused.

- §15.3 (m) Harmful interference. Any emission, radiation or induction that endangers the functioning of a radio navigation service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a radiocommunications service operating in accordance with this chapter.

Also include any documentation supporting the alleged existence and cause of the interference.

This information is submitted through the FCC Enforcement Bureau's online portal: https://fccprod. servicenowservices.com/psix-esix. A separate selection is available for three categories; public safety, enterprise licensees (most commercial licensees), and consumer complaints.

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Key Take aways

In this document we have provided Nokia's solution to infer and detect and address interference cases. Nokia's vast experience and knowledge in the design and deployment of microwave networks has been incorporated into the TSM-8000, NSP and WSAT systems so you the Operator may detect and resolve interference cases. The probability that you may experience an interferer has increased due to the new FCC rules however it is not assured that you will experience interference. In this more uncertain environment Nokia has the tools to provide you peace of mind.