

MICROWAVE MPLS SYSTEM DESCRIPTION

RADIO COMMUNICATIONS SYSTEM

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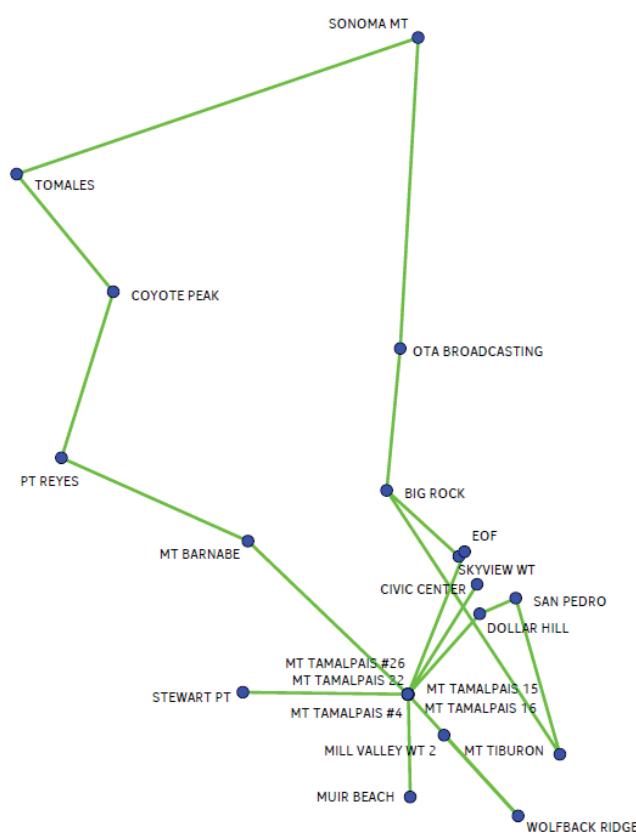


SYSTEM DESCRIPTION

The backhaul design consists of an 18 site backhaul network for Marin county and will utilize Nokia's Wavence Microwave Packet Radio (formerly referred to as the 9500MPR) along with the Nokia 7705-SAR Service Aggregation Router. This will be an integrated solution where the 7705-SAR will be equipped with microwave aware packet microwave cards (PMC) providing the interface and control for the Wavence microwave transceivers. The backhaul system will be managed using the Nokia Network Services Platform (NSP) NFM-P network management system.

The Wavence MPR radios will be configured as hot-standby for high availability on linear spur routes, and non-standby in the ring topology where network resiliency can be maintained using the MPLS Fast Re-route (FRR) features of the 7705 SAR routers. The 7705-SAR's will also provide the ethernet and TDM interfaces for the customer premise equipment (CPE) that will ride over the backhaul network. The microwave radio paths will have a bandwidth capacity of 160Mbps each, in upper and lower 6Ghz and 11Ghz FCC licensed frequency bands.

The diagram below indicates the proposed network design.



PACKET MICROWAVE TRANSPORT NETWORK

The Nokia Wavence Microwave Packet Radio offers the highest density of TDM, Ethernet and radio directions on the market. Less rack space, lower power consumption equating to lower HVAC requirement and higher reliability with minimum spares and ease of operation with point and click web interface provides the highest value to Operations and Engineers maintaining your network.

Wavence provides seamless Internet Protocol (IP) migration for microwave networks. The Wavence microwave radio handles traffic by packet natively, using IP instead of inefficient Time Division Multiplexing (TDM) formats, yet it still fully supports TDM circuits, providing a means to maintain legacy TDM with new IP applications or gracefully and seamlessly migrate to an all-IP infrastructure. The Wavence is a nodal radio concept which consists of two major components: The microwave aware PMC integrating the Wavence radio with the 7705-SAR, and the microwave radio transceiver. In the Marin County application, the indoor MPT-HLC transceiver will be used along with the 7705-SAR PMC.

The Wavence MPR offers the highest system gain across the broadest portfolio utilizing the optimum mix of high transmit power and low receiver sensitivity providing the maximum flexibility and cost savings to the Mission Critical Operation. The Nokia solution also supports a strong Forward Error Correction (FEC) and high Dispersive Fade Margin (DFM) for every modulation and this allows for the highest system gain.



Wavence indoor MPT-HLC radio transceiver

7705-SAR - IP/MPLS SERVICE AGGREGATION ROUTER

The Nokia 7705 SAR portfolio is optimized for multiservice adaptation, aggregation and routing, especially onto a modern Ethernet and IP/MPLS infrastructure. Leveraging the powerful Service Router Operating System (SR OS), the 7705 SAR is available in compact, low power-consumption platforms that deliver highly available services over resilient and flexible network topologies.

Router-Radio: Product Convergence

The 7705 Service Aggregation Router and the Wavence Microwave Packet Radio are a high value, managed combination for flexible aggregation and backhaul. To support the delivery of market-leading integrated IP/MPLS and microwave mobile backhaul solutions. The backhaul design includes the 7705 SAR and Wavence MPR MPT-HLC (Indoor Unit).

This capability brings the optimal combination of cost-efficient connectivity via microwave packet radio with the determinism, resiliency, scalability and end-to-end control and management of IP and MPLS networking. The Wavence MPR is ideally suited to enhance the 7705 SAR by adding an efficient, validated microwave transport networking capability integrated with the IP/MPLS router. The new IP/MPLS-centric backhaul networks, the combination of the 7705 SAR and the Wavence MPR MPT-HLC enables an attractive backhaul option with significant competitive differentiators.

Best cost and performance in all scenarios

- Common Radio throughout the network (less CAPEX and OPEX)
- Reduces amount of deployed indoor equipment at each site (less CAPEX)
- E2E common OAM procedures and protection over microwave and fixed media (less OPEX)
- Low power consumption at each site (less OPEX)



7705 SAR-8 (Service Aggregation Router)

QoS

Service Router Operating System (SR 0S) software provides superior quality of service (QoS) on the 7705 SAR. The same level of deep buffering and support for ingress and egress shaping. Consistency of traffic engineering and shaping across the network provides higher packet routing performance overall with differentiated service treatment. This facilitates the convergence of fixed and mobile traffic for service providers as well as operational services traffic for mission-critical networks.

MPLS

The network incorporates the MPLS layer 3 protocols; the design will include 7705 SAR-8 routers to provide a robust network throughout the system. Multi-Protocol Label Switching is a technique of delivering data packets from source to destination via an optimal route, and that packets are prioritized appropriately. At the input to the network, a data packet is assigned a forwarding Equivalence Class (FEC) indicated by appending one or more labels. As each packet passes through the MPLS network, packets are delivered and treated by the identified FEC. Labels may be added or replaced but the identified FEC is maintained End to End. At the destination, labels are stripped off and the data packet is delivered.

This gives the MPLS network the ability to handle packets with particular characteristics (such as coming from particular ports or carrying traffic of particular application types) in a consistent fashion. Packets carrying real-time traffic, such as voice or video, can easily be mapped to low-latency routes across the network — something that's challenging with conventional routing and switching. The benefits are listed below:

#	<u>Benefits</u>	<u>Attribute</u>	<u>MPLS</u>
1	Provides flexibility to add additional services, such security camera, fire cameras and data services.	Supported services	L2 PTP and L2 Mesh L3 VPN's
2	Prevents overlapping of services to prevent outages in a public safety system.	Isolation of services from each other and the transport	Best
3	Ability to support different types of traffic and allows for automatic configuration of the network.	Scalability	Best

4	Prevents and reduces the possibility of a service tech from creating a county wide radio outage. Outages will be isolated. Reduces the time to diagnose and correct the issue versus layer 2. A layer 2 topology becomes difficult to determine the root cause of a broadcast storm or (outage).	Resiliency	Improved up-time
5	The ability to manage and control Quality of Service priorities; the ability to efficiently manage what traffic gets through or held up in cue for delivery later.	Quality of Service	Optimal
6	Provides the greatest Insurance that the radio traffic bandwidth will be guarantee. In addition to providing the highest priority.	Traffic Engineering	Optimal: Improved end user experience – By allowing multiple Classes of Service to different types of traffic such as Voice.
7	Provide increase security preventing cyber attacks	Security	Optimal
8	MPLS-based services improve disaster recovery in a variety of ways. First and foremost, The Core and other key sites can be connected in multiply redundant ways to the cloud (and thus to other sites on the network). Secondly, remote sites can quickly and easily reconnect to backup paths.	Disaster recovery	Optimal: Fast recovery times and many tools to provide backup routes
9	Future Expansion	Future proofing the network	Optimal
10	Because of the any-to-any nature of MPLS services, network designers can reduce the number of “hops” between network points, which translates directly to increased response time and improved application performance.	Improved performance	Optimal

SYNCHRONIZATION

The Nokia 9500 MPR product family supports synchronization inputs on a variety of interfaces. Once selected, the input is passed through a phase locked loop for stability and passed to all other interface ports. The decision on which input to use as the sync source and which output to use to pass the sync signal along, is chosen by the user during the configuration of the radio. The choices can be changed at any time.

In the proposed 9500 configurations, Sync IN/OUT can be through SFP ports on the CorEvo (CPU) card, on one of the DS1's on the DS1 interface card or as Sync-E on a Core card Ethernet port.

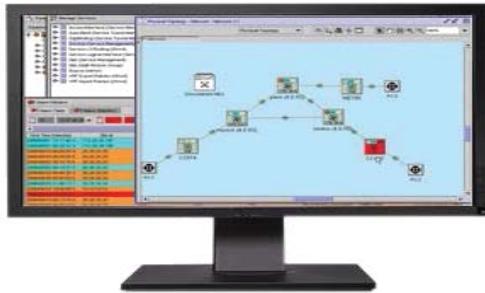
At the first node of a microwave network, the clock can be locked to any one of the following sources:

- SyncE QL-SEC/EEC1 ITU-T G.8262
- E1/T1/ DS3 line clock from any input interface 1.544 MHz QL-SSU-A ITU-T G.812
- STM-1 SDH/SONET OC-3 line clock 1.544 MHz
- IEEE 1588V2
- Dedicated sync-in port for a waveform frequency signal at 2.048, 5 or 10 MHz QL-SSU-A ITU-T G.812.

The system design includes a Trak 9100 unit.; this hardware will be utilized to interface to the microwave system. The dedicated sync-in port for a waveform frequency signal at 10 MHz QL-SSU-A ITU-T G.812 will be connected.



NETWORK FUNCTION MANAGER OVERVIEW



Network Function Manager for Packet (NFM-P)

Network Management System

The Nokia Network Services Platform (NSP) with its subset module, Network Function Manager for Packet NFM-P, enables IP network and service management across all domains of IP/MPLS networks — delivering unified operations, whether network services are running in a virtualized environment or on specialized hardware platforms. The NFM-P helps operators to quickly maximize operational efficiencies through fast provisioning and troubleshooting, proactive assurance and flexibility to ease integration into the network.

The NFM-P module provides comprehensive IP infrastructure management for configuration, provisioning, assurance and mediation of IP network devices, domains and services across IP access, aggregation, metro and core. This includes management from backhaul to packet core as well as IP/microwave transmission.

Continuous collection of key performance indicators (KPIs) enables monitoring of network wide performance and service health. Advanced troubleshooting and service assurance help to resolve problems fast, before they impact end users or applications. Unique multivendor route analytics capabilities provide proactive control plane assurance and deliver visibility into the dynamic IP/MPLS routing plane and services. Ease of integration within the existing operational environment helps network operators get the most from their existing operations support system (OSS) and business support system (BSS) investments.

The NFM-P module is a proven solution that is widely deployed worldwide in over 600 service provider networks for mobile, enterprise, residential and converged services delivery.

IP infrastructure and services management

NFM-P IP infrastructure management provides base Fault, Configuration, Accounting, Performance and Security (FCAPS) management with many advanced extensions for IP/MPLS tunnel management, templates and automated creation. This includes management of policies for device configuration, including for physical and logical resources, buffers, queuing, QoS marking/forwarding and access control lists (ACLs). IP infrastructure and services management provides centralized views for listing

physical inventory, IP/MPLS paths and services. These views also provide an easy starting point for performing maintenance and troubleshooting that includes search filters, status indicators, and in context cross-navigation to configuration forms and topology maps. The NFM-P provides topology views for both physical and logical network layers. Physical topologies support IEEE 802.1ab link adjacencies using Link Layer Discovery Protocol (LLDP). All topology maps include a variety of status indicators allowing cross-navigation to alarm management with fault correlation, OAM test-suites, integrated multivendor route analytics and a wide range of apps for network operations. Specifically, for fault management, topology overlays provide alarm status and additional troubleshooting information, such as port and link utilization statistics, or OAM test results with trace highlighting after point-and click execution from a map.

IP network service provisioning

The NFM-P accelerates service deployment with service templates and scripts for provisioning, rules-based QoS and accounting policy assignment, and automated SLA validation. External systems are able to access service management functionality through an open OSS interface (XML). NFM-P service templates and workflows enable point-and-click service creation. Operators are guided step-by-step as they set up complex services for rapid provisioning and fewer errors. Templates also enable operators to customize and standardize their provisioning workflow to match internal processes. Layer 2 and Layer 3 services are provisioned in the same way, reducing delivery costs for different service types. Newly activated services can be validated using a service test suite. Tests are automatically extended as services expand so test coverage does not drop off over time. Individual component tests for the newly provisioned entity are automatically created and include detailed test results.

All MPLS platforms incorporated in the solution recommended by Nokia are managed by a common management system, the Network Functional Manager (NFM), for streamlined service creation and control with service-aware OAM tools for rapid troubleshooting. The NFM system gives network operators a graphical display of the hierarchy and relationships amongst the network resources and is able to present the operator with a complete picture of a service allowing for rapid recognition of and reaction to problems. With service-based knowledge, when problems occur in the network, the operator knows what services are affected, who the client is and, to what degree their services are compromised.

The NFM provides a variety of OAM tools to proactively monitor the health of the end-to-end services as well as the underlying network. Service assurance agents (SAA) can periodically test jitter, latency, and packet loss within individual forwarding classes and trigger alarms based upon user defined thresholds. These test results can be displayed in a graphical format on the NFM client. Upon detection of troubles, the operator can use the OAM tools to isolate the fault within the network. These tools are also available from the CLI on the nodes.

Additional capabilities of the NFM include:

- Intuitive service creation and provisioning which has been proven to reduce the learning curve for operators to achieve management efficiency
- Advanced correlation of network events to services and affected applications allows operators to customize the manner in which they trouble-shoot. This is made feasible by providing views to events

related to specific services and giving enhanced sorting options as well as flexibility to drill from a network level to an element level to a specific flow with point-and-click efficiency

- Execution and visualization of end-to-end OAM functions such as “Service Ping” which allows an operator to inject a test packet to verify proper operation of the customer’s data path to expedite trouble resolution and visualize the entire data path traversed as well as to determine the fault location.
- Fault impact and root cause analysis with network wide visibility and options for isolation, with graphical on-screen representation, on a per service basis.
- Simplified OSS integration. The NFM has many XML based interface adaptors developed with OSS vendors to assure a rapid and successful integration into an operator’s OSS environment.

By leveraging the next generation Service routing capabilities of the 7705 SAR, the NFM can manage network devices essentially as a single virtual node, enabling rapid service activation, modification, trouble-shooting and accounting while minimizing complexity and overhead cost for training, operation and OSS system integration. The NFM can also be configured to manage the Wavence MPR alarm and system monitoring operations.



ASSOCIATED EQUIPMENT

Also Included as part of the microwave system are new antennas and waveguide with associated hardware for mounting on the tower structures at each of the 18 microwave sites.

Inside the microwave shelters the Wavence MPT-HLC microwave transceivers and 7705-SAR's will be installed into a new standard equipment rack with a power distribution unit at the top of the rack. All associated cables and miscellaneous materials will be provided to complete the microwave radio installation.

SUMMARY

Migrating to an all packet microwave radio network using IP/MPLS will enable Marin County to gain the network flexibility, reliability and scalability that is needed to provide both current and future mission-critical services.

