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Proxim WIRELESS NETWORKS
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WIRELESS OUTDOOR ROUTER PROTOCOL

What is WORP?

WORP is a new protocol that is designed to optimize the performance of outdoor wireless point-to-point and point-to-multipoint links using 802.11b radios

The use of 802.11b radios and bridges enables Proxim to offer a low cost, feature-rich solution that is ideal for economical last mile access and campus networking.

WORP takes care of the performance degradation that happens when standards-based 802.11b wireless LAN technology is used for outdoor building-to-building connectivity, incurred by the so-called “hidden-node” problem.

What is the “Hidden-Node” Problem?

All wireless CSMA/CA and 802.11 radios assume that all nodes have carrier sensing (detection of signal). This means that all the radios in a system can “hear” each other’s radios signals and not transmit if others are transmitting.

This is easily achieved in an in-building installation but is not feasible in outdoor point-to-multipoint environments. The Request-To-Send/Clear-To-Send mechanism (RTS/CTS), an attempted solution to this issue, is a concept that has been included in 802.11 standard but does not solve the “hidden node” problem.

In a network with only a handful of users, a standard 802.11b radio will work outdoors. However, when there is a need to scale the network beyond that, then an RTS that is sent from a Subscriber Unit to the Base Station will corrupt any data that other Subscriber Units are currently sending. This results in unnecessary packet loss and multiple re-transmissions, causing the network performance to drop dramatically.

The WORP polling algorithm ensures that these collisions cannot occur, which increases the performance of the overall network significantly.

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What are the benefits of WORP in an outdoor environment?

WORP over Wireless LAN Access Point Solutions

More Net Bandwidth

By solving the hidden node problem, WORP increases the overall net bandwidth of the multipoint system. The net bandwidth compared to a standard Wi-Fi Access Point solution used in an outdoor environment can be increased up to 6 Mb/s using WORP. The background for this is that WORP is a more efficient protocol that protects the system for collisions, which increases the overall performance.

More Concurrent Subscribers

An outdoor point-to-multipoint solution based on 802.11b may connect from 5 to 10 remote nodes, but sometimes performance starts to suffer from collisions with as little as only 2 remote nodes. A solution using WORP, on the other hand, can connect up to 100 remote nodes without adverse effects on usable bandwidth, allowing more concurrent Subscriber Units to be active in a wireless multipoint environment.

Bandwidth Control

WORP allows the service provider to control network bandwidth, protecting the network from excessive use of the bandwidth by any one station. Additionally it allows the service providers to differentiate their service offerings.

Asymmetric Bandwidth Control

Asymmetric bandwidth gives the network manager the ability to set different maximum bandwidth rates for a variety of customer groups. This allows service providers to further differentiate their service offerings and maximize revenues.

WORP Over the Legacy Outdoor Router Solution

The WORP protocol is a more efficient protocol than the protocol used in the legacy outdoor router system.

Benefits of WORP over the legacy Outdoor Router solution are:

- Increased net bandwidth
- More concurrent subscribers on the same Base Station
- Asymmetric bandwidth control
- Ability to provide link statistics

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WORP Functionality

Broadcasts & Registration

In a WORP based system, the Base Station Unit (BSU) acts as the traffic controller. For a Subscriber Unit (SU) to recognize the system, the Base Station transmits broadcasts. These broadcasts occur every 150 ms.

The BSU only broadcasts to SUs that have the same encryption key, network name and Base Station Name.

A station that wants to join can do so as soon as it sees the BSU's broadcast. When the maximum number of SUs have registered to the base station, the broadcasts will stop until a Subscriber Unit deregisters.

Registration and mutual authentication is based on MD-5 using a shared secret. Bandwidth negotiation for the specific Subscriber Unit occurs between SU and BSU to perform bandwidth management. For every registered SU one bridge port number is allocated, up to a 100 maximum.

Polling Satellites, Request for Service and Dynamic Scheduling

The BSU will poll each satellite regularly, minimally every 4 seconds (sleep mode). When a SU has new data, it will request to be polled immediately – if it was not polled since the last broadcast – as soon as it sees the BSU broadcast . The BSU schedules the SUs for polling dynamically; based on the amount of data they have waiting to optimize the use of the available bandwidth.

Windowing, Retransmit and Timeout

Data is sent between SU and BSU with an incrementing sequence number, and every frame is acknowledged. New data is sent immediately even if the "window" of sequence numbers is not yet filled. Bottom of the window is the last acknowledged sequence number.

Retransmission only occurs when several frames have been sent for which no acknowledgment has been received. Retransmission is done selectively on the missing frames only.

Timeout and discard happens when data is too long in TX queue: (more than 1.5 sec with a max buffer size of 512 frames) and when data is too long in retransmit queue (16 entries) with timeout dependent on the radio data rate and the number of Subscriber Units registered.

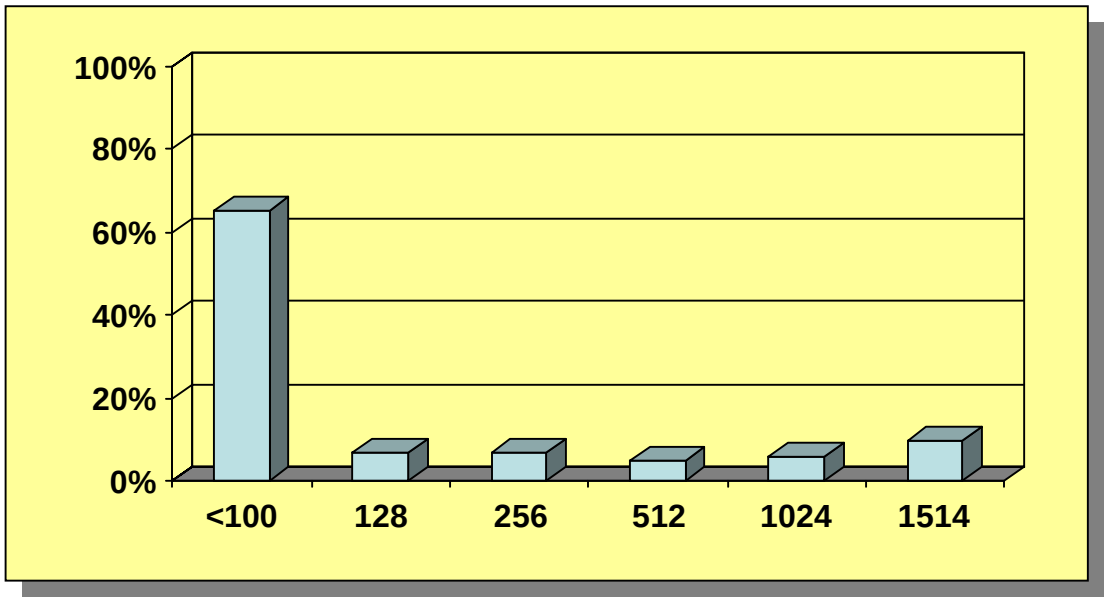
Deregistration

Deregistration happens when BSU or SU have not seen their peer for 30 seconds. The BSU considers the SU deregistered and it needs to re-register as soon as it sees the BSU broadcast again.

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Throughput, Super-Packeting and Fragmentation

In a network environment, maximum performance will be achieved when the 802.11 frames have data-packet sizes of 2304 bytes. Ethernet packets have maximum 1514 bytes. Generally 60% of IP messages are short (<100 bytes). These short frames impact the effective throughput.



WORP uses super-packeting and fragmentation to improve the effective throughput of the system by minimizing the overhead.

With super-packeting, WORP puts multiple packets into one frame. Fragmentation splits packets over 2 frames.

Encryption

All WORP communication is sent in data frames, so they are always following the encryption status. For encryption, WEP 64 and 128 bits encryption is used with Weak Key avoidance (WEP+).

In the current release a static encryption key is used. With 128 bit encryption turned on, the system achieves 85% of its normal performance.

Bandwidth Control

The network service provider can limit (throttle) the bandwidth that each customer is allowed to use. This is accomplished in the Subscriber Units. Bandwidth control can be configured per SU-BSU link. It is asymmetric, upstream and downstream can be configured independently, so the service providers can provide various service offerings to their customers.

Bandwidth control is a security mechanism for the ISP. It guarantees fair sharing of the available bandwidth over the active systems, so one single subscriber cannot completely consume all the bandwidth in the system.

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Bandwidth control is able to set the Maximum Information Rate (MIR) but not the Committed Information Rate (CIR). Bandwidth control can be configured in 2 ways: static in each interface on the Subscriber Unit and Base Station Unit or centrally via a Radius Server.

WORP Security

WORP offers a variety of security features for securing data in the network. First, the protocol is not publicized or standardized, which makes it less vulnerable for hackers than a Wi-Fi based system. Secondly, WORP requires the SU to register on the Base to do a mutual authentication with identification via a MD-5 secret string. Both know that their peer belongs to the network (avoiding both rogue SU and BSU). Additionally WORP uses 128 bit encryption using WEP+ with weak key avoidance to encrypt the data being sent. Fourth, Access Control (authentication) occurs locally and via Radius server.

Finally, all remote management methods are password-protected. Different passwords can be set for SNMP read, SNMP read/write, Telnet and HTTP.

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