Repeater User Guide

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MaxStream

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Overview

MaxStream's repeater network can significantly enhance the range and reliability of a wireless system. The network repeats each message among all available nodes exactly once. This mechanism eliminates the need for configuring specific routes. The network is self-organizing and self-healing so that the system can repeat data around a node that goes down. The network supports RF packets up to 256 bytes on XStream and 2048 bytes on XTend radio modems. The repeater network can work in either an addressed or a transparent mode for multi-drop networks and works well in many systems with no special configuration.

Commands used to configure functionality

AT Command	Binary Command	AT Command Name	Range	Command Category	# Bytes Returned	Factory Default
MR	0x3C (60d)	Repeater Mode	0–2	Networking	1	0
MY	0x2A (42d)	Source Address	0–0xFFFF	Networking	2	0xFFFF
AM	0x40 (64d)	Auto-set MY	–	Networking	–	–
DT	0x00 (0d)	Destination Address	0–0xFFFF	Networking	2	0
RN	0x19 (25d)	Delay Slots	0–0xFF (slots)	Networking	1	0

Network features

- No route configuration necessary - self-organizing
- Fault tolerant - self-healing
- No route maintenance – RF traffic only to send payload through the network results in low power consumption and less interference.
- Network throughput is determined by number of hops, not by number of repeaters. Multiple repeaters within range of the source node count as one hop.
- Supports "transparent" multi-drop mode or addressed data filtering mode.
- Automatically filters out any duplicate packets.
- All packets propagate to every node in the network (address filtering rules apply).
- In broadcast mode each packet comes out every node exactly once
- In addressed mode all radios see every packet, only the modem with a matching address will send it out the UART.
- Each node can be configured as a destination only node (D node) or as both destination and repeater (DR node).

Network constraints

- Requires that each module have a unique source address.
- System must introduce just one packet at a time to the network for transmission (256 bytes max for XStream or 2048 bytes max for XTend).
- Each hop (H) decreases network throughput by a factor of 1/(H+1). Additional repeaters add network redundancy without decreasing throughput.
- Repeater nodes need to be powered on to repeat.

Network configuration instructions

- Assign each radio modem a unique source (MY) address (use ATAM to configure unique source address based on radio serial number, if desired).
- Select broadcast mode (ATDT FFFF) or addressed mode (ATDT specifies a specific destination)
- Configure PK, RO and RB to ensure that RF packet aligns with protocol packet. (ex. PK=0x100, RB=0x100, RO depends on baud rate).
- Configure one or more repeaters in the system (ATMR 1).
- Configure remote nodes as destinations (ATMR 2). This will ensure that the remote node waits for the repeater traffic to subside before it transmits a response.

Theory of operation

Instead of using routing tables and path discovery to establish unique paths through a network, the repeater system uses a sophisticated broadcast repeating algorithm to propagate each packet through the entire repeater network. Using the addressing capabilities of the modems, a packet can be sent as a global packet and shift out of every radio in the network. Alternatively, the packet can be sent with a specific destination address so that it is only accepted by a specific remote node.

Example

Consider radio nodes R1 through R10 each communicating to a PLC using ModBus protocol and spaced evenly in a line. All 10 nodes are configured as destinations & repeaters for broadcast mode (MR=1, AM, DT=0xFFFF, PK=0x100, RO=0x03, RB=0x100, RN=1). Base Host (BH) shifts payload into R1 destined for Remote Host 10 (RH10) connected to R10. R1 initializes RF communication and transmits payload to nodes R2 through R5 which are all within range of R1. Radios R2 through R5 receive the packet and retransmit it simultaneously. They also send the data out the serial ports, to the PLC's.

Network bandwidth considerations

Using mesh repeaters in a network reduces the overall network data throughput as each repeater must buffer an entire packet before retransmitting it. For example: if the destination is within range of the transmitter and the packet is 32 bytes long, the transmission will take 72ms on a 9600 baud XStream modem (much faster modems are available). If that same packet has to propagate through two repeaters, it will take 72ms to arrive at the first repeater, another 72 ms to get to the second and a final 72ms to get to the destination for a total of 216ms. Taking into account UART transfer times (~1ms/byte at 9600 baud), a server to send a 32 byte query and receive a 32 byte response in about 200ms, allowing for 5 polls per second. With the two repeaters in the path, the same query/response sequence would take about 500ms for 2 polls per second.

To summarize, this system is sending and receiving 64 bytes 5 times per second for a throughput of 320 bytes per second with no repeaters and 128 bytes per second with 2 repeaters. Generally, the network throughput will decrease by a factor of 1/(R+1), with R representing the number of repeaters between the source and destination.

Note that these numbers are absolutely worst case to illustrate how the system would perform in a typical, low bandwidth system. As a counter example the 115kbps 9XTend radio can transfer the same 32 byte packet in 12 ms for a round trip with UART transfer times of ~30ms or 33 polls per second (1066 bytes per second) with no repeaters. With two repeaters the time would be ~100ms round trip time for 10 polls per second or 320 bytes per second network throughput with two repeaters.