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ARF53 REPEATER TECHNICAL NOTE

Document updates

Versions	Date	Notes
A2	28/04/2009	Repetition can be forced using S250 register, Repeater in MODBUS topology
A1	24/04/2009	'Guard delay' modification, repetition size increase to 250(instead of 128)
A0	08/04/2009	PTR, creation

Reference documentation

Date/version	Description

Notations

	Description

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1 INTRODUCTION

This technical note describes the ARF53 repeater feature. Illustration of this feature is performed (in this document) through a basic configuration (2 equipments + 1 repeater), but more complicated infrastructure could be deployed (see §3.3 Typical repeater topologies).

1.1 Repeater feature

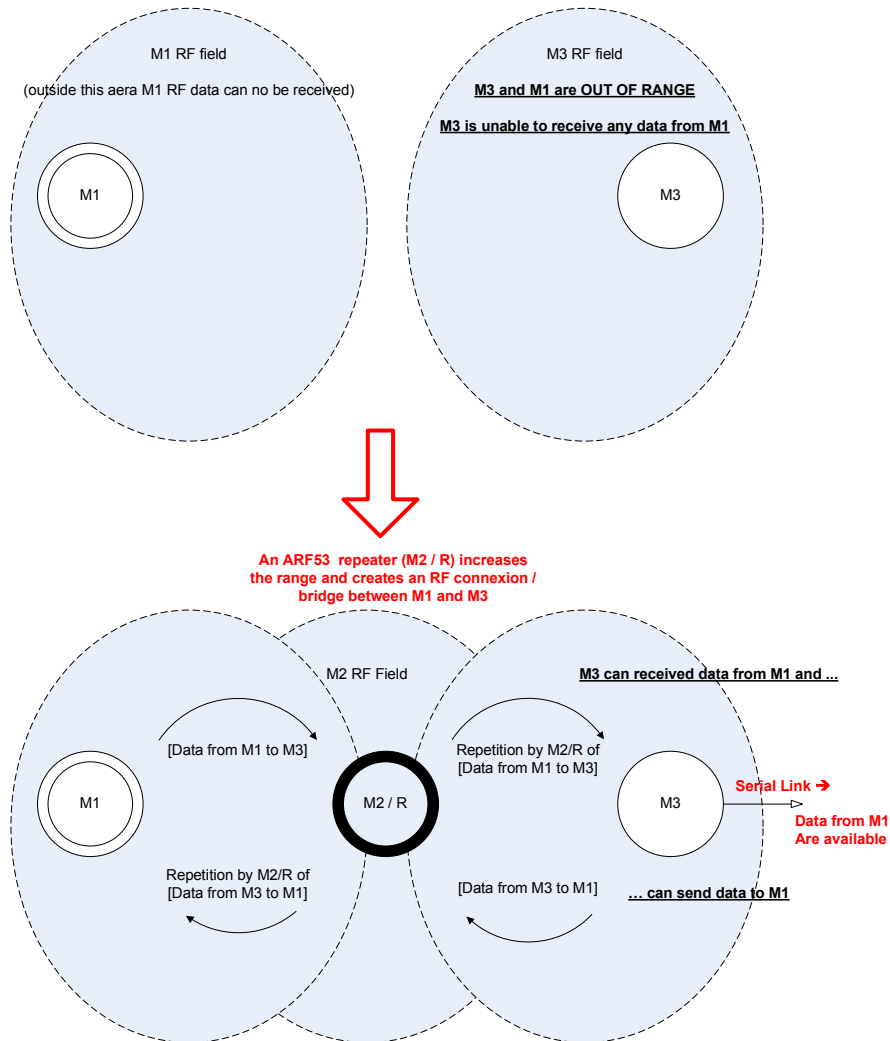


Figure 1: ARF53 repetition feature

The data sent by M1 are received by M2/R but are not available on M2/R serial link (the frame destination address is M3).

- **RF frame repeated:**
 - When S250=0, an RF frame is repeated only if the RF frame is different from the repeater reception @ (S252 register) or if the RF frame is broadcasted (RF frame@=FFFF).
 - When S250=1 the repetition is forced even if the frame is addressed to the repeater.
- **Reception of same RF Frame:** If the same RF frame is received several times by a repeater within 10s, only the first occurrence of the RF frame is repeated.
- **Serialization for a repeater:** An RF frame is serialized on a repeater only if the RF frame@ is equal to the repeater reception @ (S252 register) or if the frame is broadcasted (RF frame@=FFFF).

CAUTION: the repeater feature is available only for firmware version \geq V01.00.

1.2 Broadcast feature

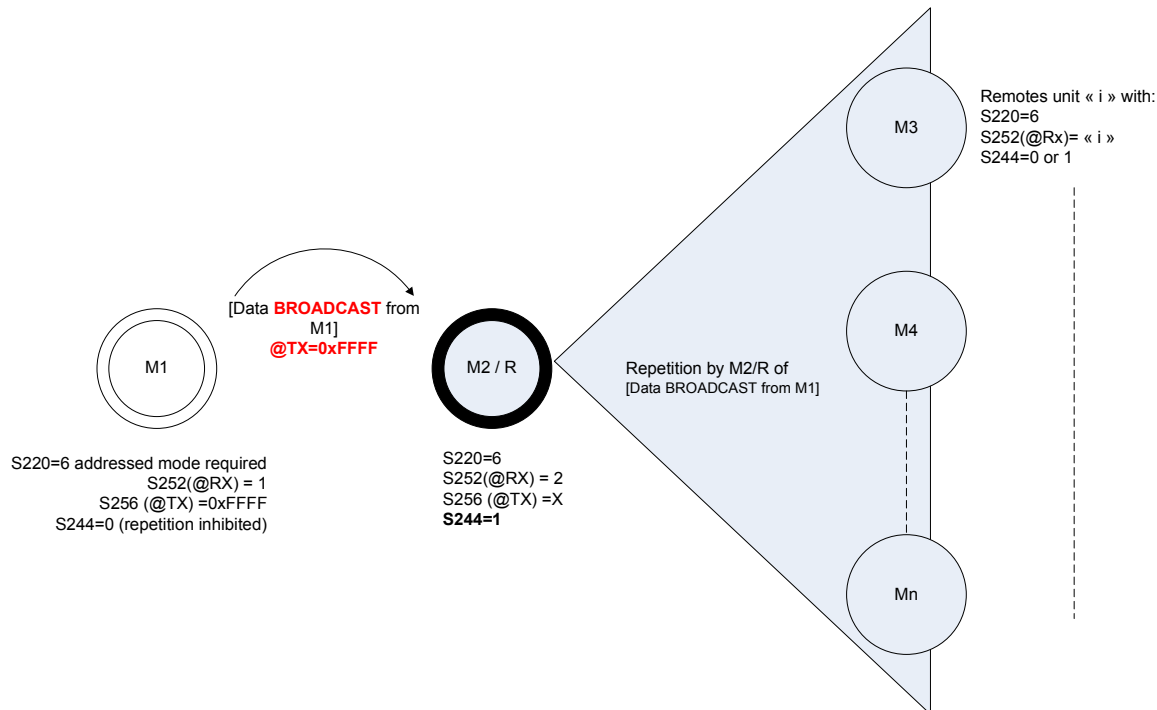


Figure 2: Message broadcast

The data broadcasted by M1 (using @TX=0xFFFF) are received (via the repeater or not) by all other units. The broadcasted data are available on all units serial link (repeater included).

CAUTION: the broadcast feature is available only for firmware version \geq V01.00.

2 REPEATER SETUP

The repeater setup is performed through AT commands via the registers described below.

2.1 Installation requirement

The following requirements are mandatory when using the repetition feature:

- **All devices MUST be configured in addressed mode** (S220=6), with default preamble value (using another preamble length will alter the repeater propagation delay calculation)
- **The size of the exchange message is limited to 250 bytes** (for example in a query / answer based exchange, the maximum length for a query or for an answer must not exceed 250 bytes)
- **The message to be repeated must not be fragmented on the air.** For preventing RF frame fragmentation see § 2.3 “Preventing RF frame fragmentation”.
- The additional time introduces by the repeater **MUST** be taken into account in the message path.

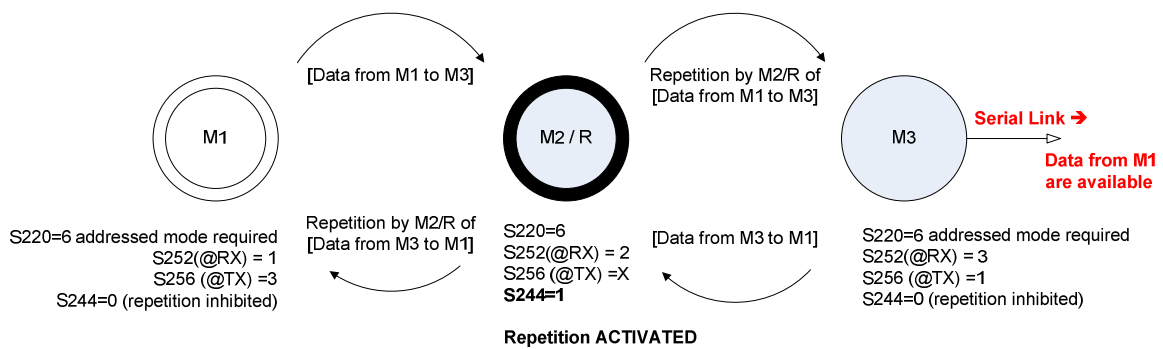


Figure 3: ARF53 typical register configuration for repetition

2.2 Repeater registers

Parts of the registers are already described in the unit datasheet. Default values are in **bold**.

Register	Function	Description
S220	Mode	'1' transparent mode '6' addressed mode → required for using repeater feature
S252	Local address @RX	From 0 to FFFF Reception filter (incoming RF frame will be discarded if the frame address differs from this value). 0xFFFF reserved for broadcast
S256	Destination address @TX	From 0 to FFFF @ used for sending an RF frame (in addressed mode) when data are received on the serial link
S244	Repeater number	From 0 to 100. 0 : repetition is not activated (default value) 1-100 → repeater activated ; this value is used to determine the repeater guard delays (see § 3.1 Repeater propagation delay)
S250	Repetition forced	0 → conditional repetition (see § 1.1 Repeater feature) 1 → unconditional repetition (all incoming RF frame are repeated, no address analysis)

2.3 Preventing RF frame fragmentation (mixing Serial rate and RF rate)

The unit can operate:

- With two different air rate: in NB the RF rates is 10 kbit/s, in WB the RF rate is 57.6 kbit/s.
- The serial rate is in the range 600 bits/s up to 57.6 kbit/s

When using an air rate (RF rate) different from the serial rate, the RF frame can be fragmented.

A repeater can operate properly only if the RF frame is not fragmented.

The S218 register can be used (as described below) for avoiding the RF frame fragmentation or data loss (due to serial underrun).

RF rate	Serial Rate (bit/s) range	Required configuration for S218 register	Note
NB (10 kbit/s)	[4800-57600]	≥ Default (128)	
NB (10kbit/s)	[600-2400]	S218=240	
WB (57.6 kbit/s)	[38400-57600]	≥ Default (128)	
WB (57.6 kbit/s)	[2400-19200]	S218=240	
WB (57.6 kbit/s)	[600-1200]	S218=240	With these slow baud rates the message size is restricted to 240 bytes

Reminder: NB is used when the RF channel, S200 register ≥ 14
WB is used when the RF channel, S200 register < 14

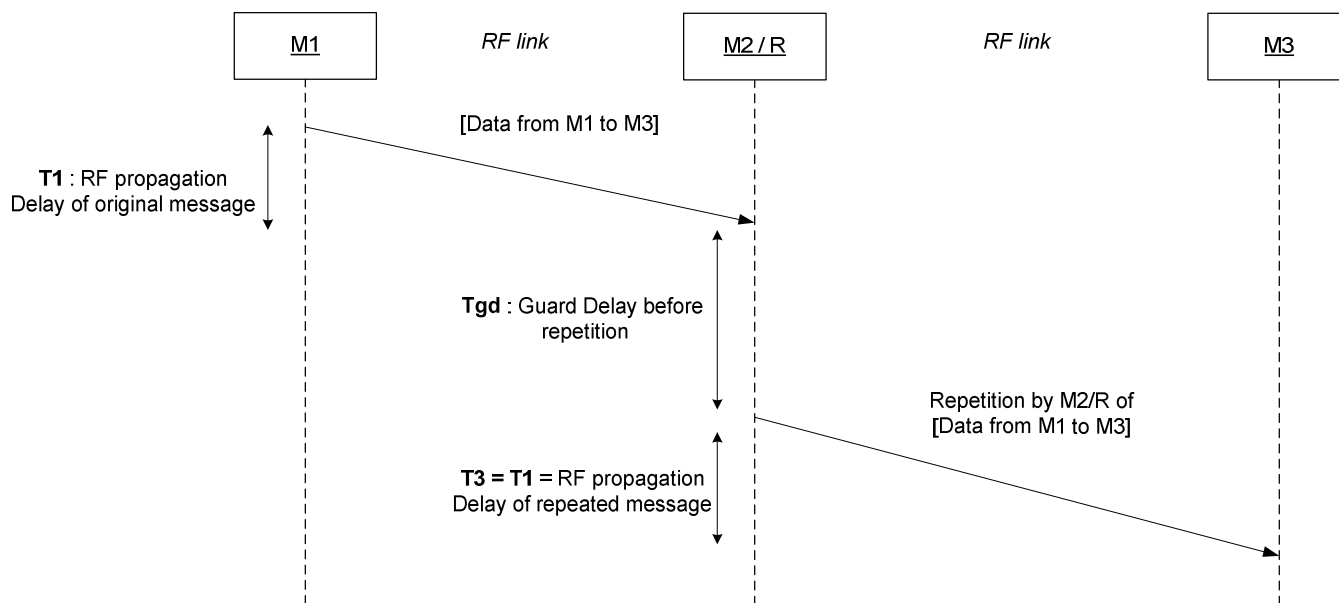
3 ADDITIONAL FEATURES

3.1 Repeater propagation delay

3.1.1 **Guard delay**

When a RF frame is received by a repeater, **the repetition is performed after a predefined guard delay**. This guard delay starts when the RF frame reception is completed. The guard delay (Tgd) is directly linked to the repeater number (S244 register):

❖ **Guard Delay in ms = S244 value x 30 ms**



Minimum RF overall message propagation delay = $2 \cdot T1 + 1 \cdot Tgd$

When Tgd is reached, the repetition is performed **ONLY** if the RF channel is free (LBT=Listen Before Talk using RSSI level analysis).

If the LBT is not successful the retransmission is postponed. If the postponed delay exceed 10s, the repetition will be discarded.

Figure 4: Repeater RF propagation delay

Caution: even if the repeater has a Listen Before Talk feature, the LBT can not prevent all RF frame collision. For avoiding repeater collision see §3.1.2 Guard delay calculation when using several repeaters.

3.1.2 Guard delay calculation when using several repeaters

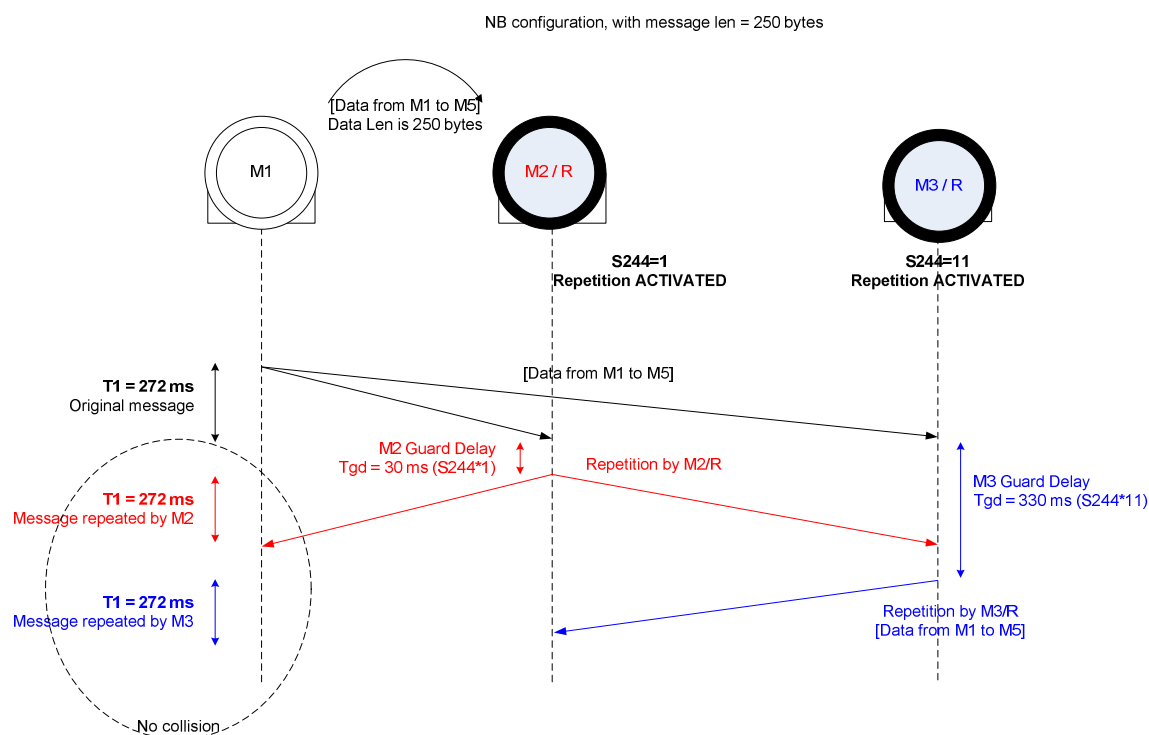
If several repeaters are **located in the same RF range**, their respective **guard delays MUST be different for avoiding RF frame collision**. The guard delay must be \geq to the RF propagation delay.

The following formula can be used for (T1) RF propagation delay calculation:

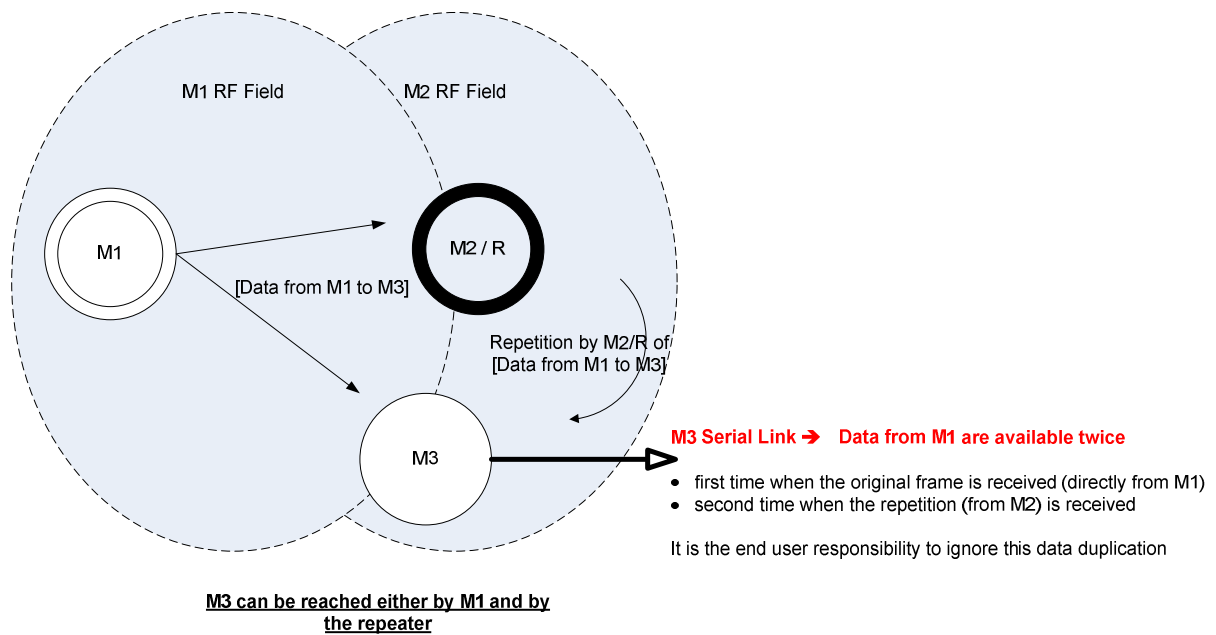
- ❖ In NB, $T1$ in ms = $22\text{ms} + (\text{nbData} * 1\text{ms})$. For a frame of 10 bytes, $T1 = 42\text{ms}$
- ❖ In WB, $T1$ in ms = $6\text{ms} + (\text{nbData} * 0.18\text{ms})$. For a frame of 10 bytes, $T1 = 8\text{ms}$

Example: if the maximum frame size is 250 bytes:

- ❖ In NB, $T1$ in ms = 272ms. S244 can be assigned to 1 for the first repeater and to 11 for the second...
- ❖ In WB, $T1$ in ms = 61 ms. S244 can be assigned to 1 for the first repeater and to 4 for the second...



3.2 Module reached by the sender and the repeater



3.3 Typical repeater topologies

3.3.1 Low density topology

In such « ideal » topology, each repeater can have the same number ($S_{244}=1$), because we assume that M_{i+2} (M_3 for example) doesn't received M_i (M_1).

Message propagation delay from M_1 to $M_5 = (4 * T_1) + (3 * T_{gd})$

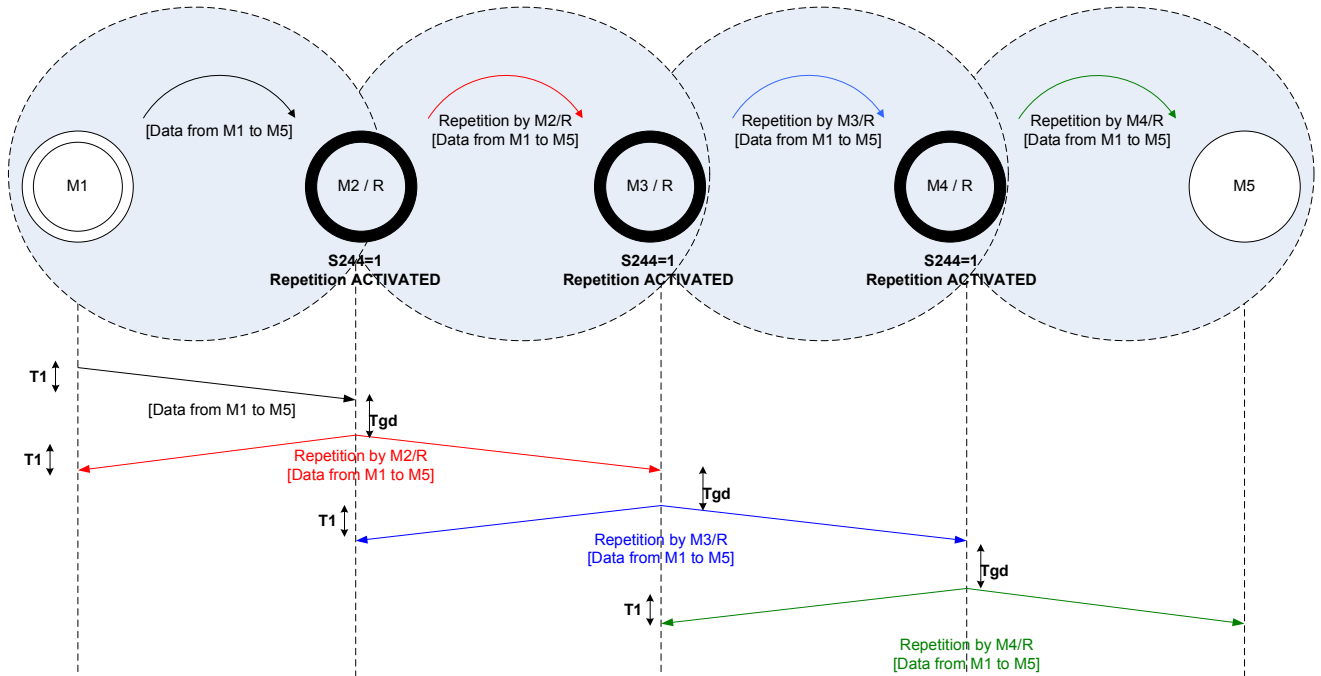


Figure 6: Low density topology

3.3.2 High density topology

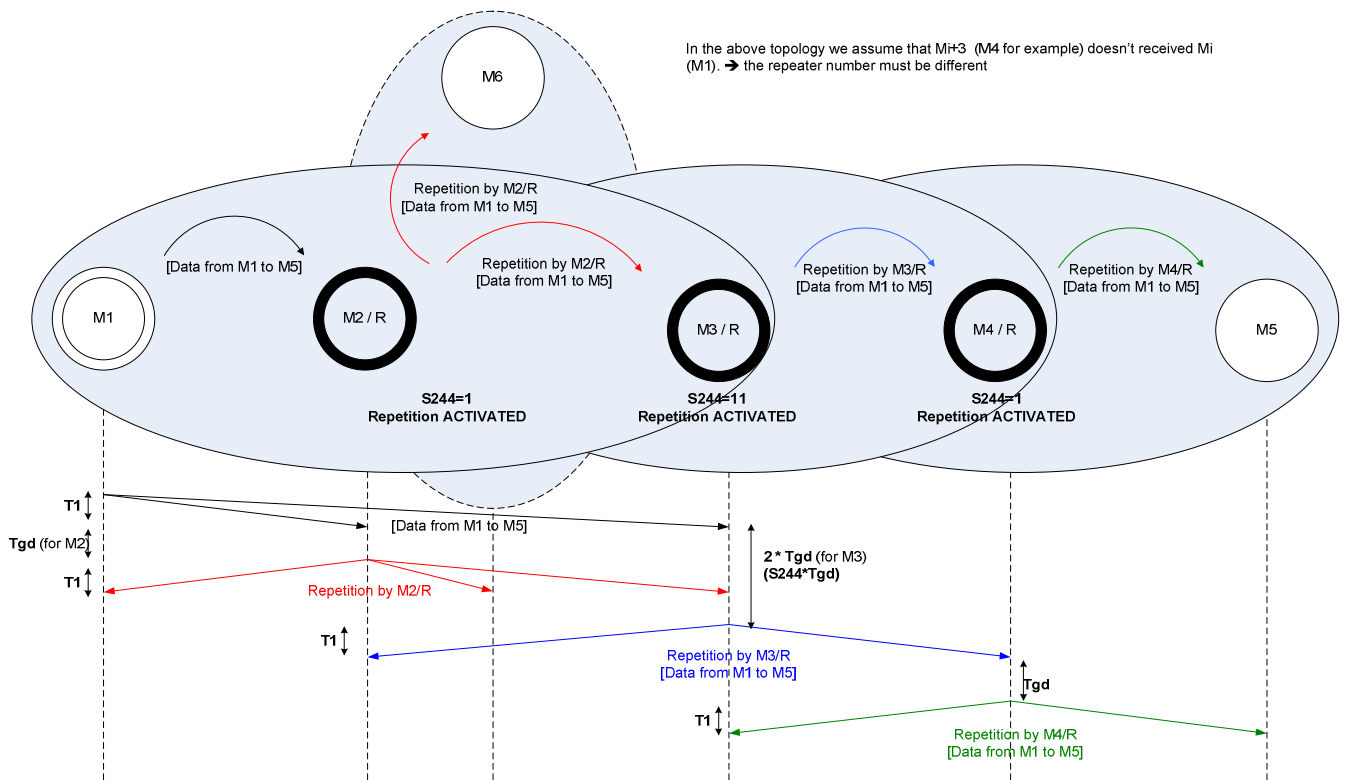


Figure 7: high density topology

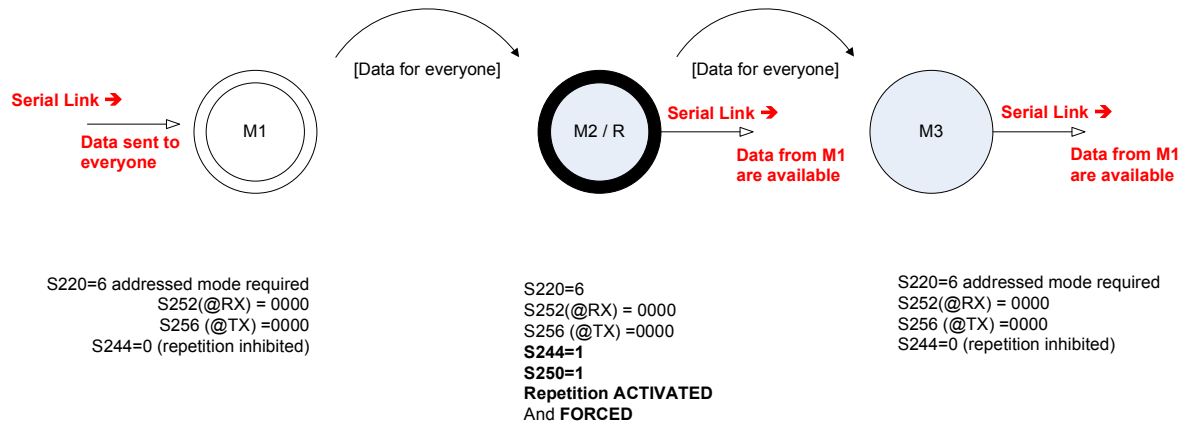
3.3.3 MODBUS topology

When using a protocol such as MODBUS:

- the address resolution is performed by the protocol used (and not by the RF media),
- assuming that **all devices** received **all exchanged** queries (such as an RS485 bus)

The S250 register complies with this requirement:

- S250 = 1 forces the repetition, even if the frame is addressed to the repeater.
- S252 and S256 RX@ and TX@ must be set to the same value for all point (default, 0x0000 can be used).



3.4 Software release and backward compatibility

CAUTION: the **repeater and broadcast features** are available only with firmware version \geq V01.00.

The repeater feature is backward compatible with ARF53 (firmware version $<$ V01.00).

- ⇒ For example the out of range devices (M1 and or M3) can have a firmware version $<$ V01.00 while M2/Repeater must have a version \geq V01.00.

Using the **broadcast feature requires that all the ARF53 have a firmware version \geq V01.00**. An ARF53 with a firmware version $<$ V01.00 can be used but it will not received the broadcasted message (excepted if its local address is set to the specific value 0xFFFF).