

SCADA PERFORMANCE COMPARISON – MODBUS SIMULATION

The objective of these tests is to evaluate and compare the performance of the Aprisa SR+ at QPSK, 16, and 64 QAM versus 'legacy' equipment of a well-known American brand operating using CPFSK. The results are the number of outstations able to be polled in 30 seconds.

Purpose

- Evaluate the performance of the Aprisa SR+ with typical SCADA loads
- Determine the network performance of the system – how many outstations can be polled in a given timeframe
- Assess the ability for the Aprisa SR+ to poll at least 100 outstations in 30 seconds

Test equipment

- Calta Computer Systems MDBus SCADA simulator to generate polling.¹
- PCs or server with multiple virtual machines to support real Ethernet RTUs
- 10 Aprisa SR+ Remote Stations
- Aprisa SR+ Base Station
- Appropriate shielded RF cabling, attenuators, splitters and power supplies

SCADA Traffic

The data load has been determined as:

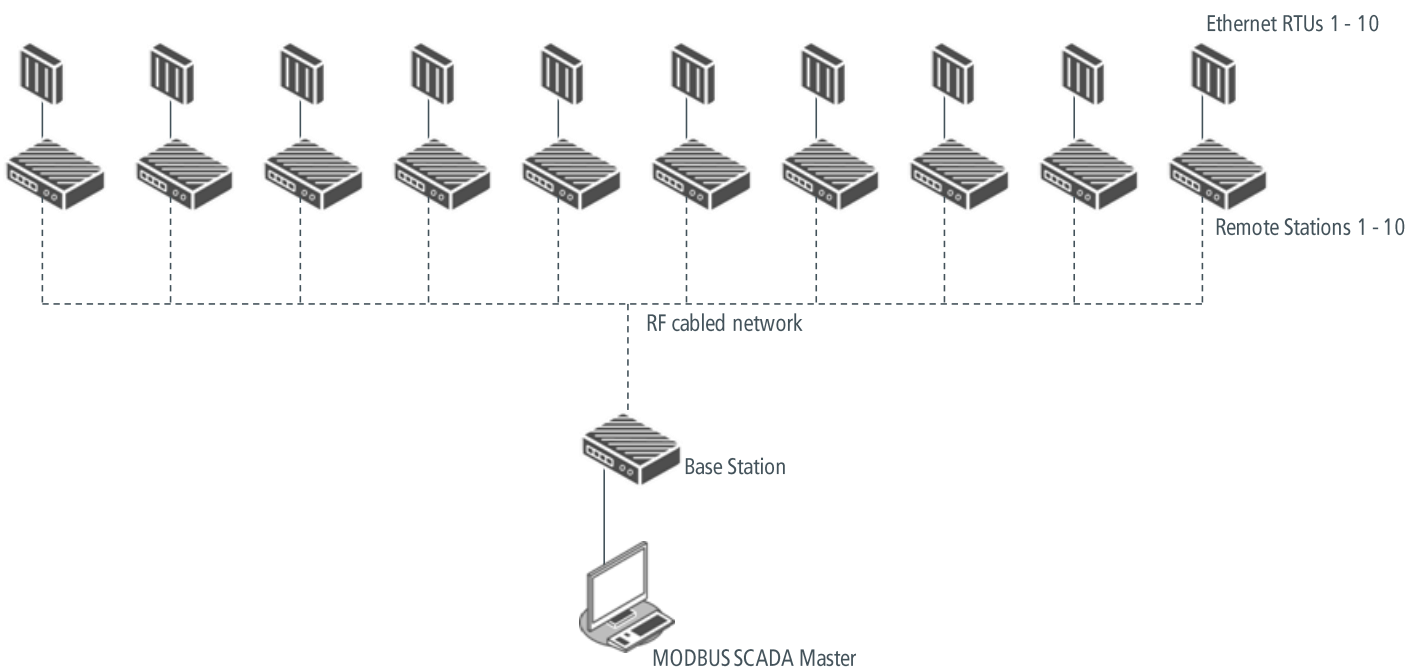
- MODBUS IP protocol using UDP
- Standard Poll request of 13 bytes
- Typical Poll Response of 260 bytes (from 104 registers)

¹ 4RF also uses a Triangle Microworks SCADA simulator for testing

High level test overview

- For this simulated SCADA test, a test network is created with Aprisa SR+ remote radios connected to real Ethernet RTUs².
- Ethernet SCADA traffic is generated based on the poll and response rates as determined above by the third-party requirements.
- The process with the polling is to poll the first RTU, receive a response and move to the second RTU, poll, and response and continue this process as fast as the network can handle.
- The polling ability of the network is then assessed as to how many polls can be sent to the number of RTUs in a given timeframe.
- This was then extrapolated out to determine the number of remotes in 30 seconds.

Test Network Setup



² These were physical Honeywell RC500 RTU devices.

Test 1 – Simulated SCADA Polling

The specific test method will change depending on the equipment set up and testing regime.

1. Configure the network as for UDP file transfer ³
2. Start the Ethernet SCADA polling at modulation schemes varying from 64 QAM down to QPSK
3. When the network is stable, begin logging
4. Run the SCADA polling for 5 minutes ⁴
5. Analyse the results
 - Number of polls within 5 minutes
 - Average number of polls per 30 seconds
6. Repeat testing at a lower exception message rate and record results
 - It is recommended to determine a number of exception message rates to load and stress the network
7. All measurements were made using the Aprisa SR+ UHF ETSI variant at 25 kHz channel spacing.

Test 1 Results Table - 64 QAM Downstream, 64 QAM Upstream

Test Number	Description	Result
1	Number of polls within 5 minutes	4240
1	Average number of polls per 30 seconds	424

Test 2 Results Table - 16 QAM Downstream, 16 QAM Upstream

Test Number	Description	Result
2	Number of polls within 5 minutes	2320
2	Average number of polls per 30 seconds	232

³ Radio configuration should be at maximum modulation, compression on, filters, etc, on to enable the fastest possible radio performance for the initial test (benchmark).

⁴ Timeframe set at 5 minutes with 30 second intervals.

Test 3 Results Table - QPSK Downstream, QPSK Upstream

Test Number	Description	Result
3	Number of polls within 5 minutes	1547
3	Average number of polls per 30 seconds	154

Test 4 Results Table - QPSK Downstream, 64 QAM Upstream

Test Number	Description	Result
4	Number of polls within 5 minutes	2800
4	Average number of polls per 30 seconds	280

Test 5 Results Table - QPSK Downstream, 16 QAM Upstream

Test Number	Description	Result
5	Number of polls within 5 minutes	1992
5	Average number of polls per 30 seconds	199

Test 6 Results Table - QPSK Downstream, QPSK Upstream

Test Number	Description	Result
6	Number of polls within 5 minutes	1547
6	Average number of polls per 30 seconds	154

Test 7

The specific test method will change depending on the equipment set up and testing regime.

1. Configure the network for UDP file transfer
2. Start the Ethernet SCADA polling at the following modulation schemes:
 - QPSK Downstream
 - QPSK Lo Upstream x 1
 - 16 QAM Lo Upstream x 2
 - 64 QAM Lo Upstream x 3
3. When the network is stable, begin logging
4. Run the SCADA polling for 5 minutes
5. Analyse the results
 - Number of polls within 5 minutes
 - Average number of polls per 30 seconds

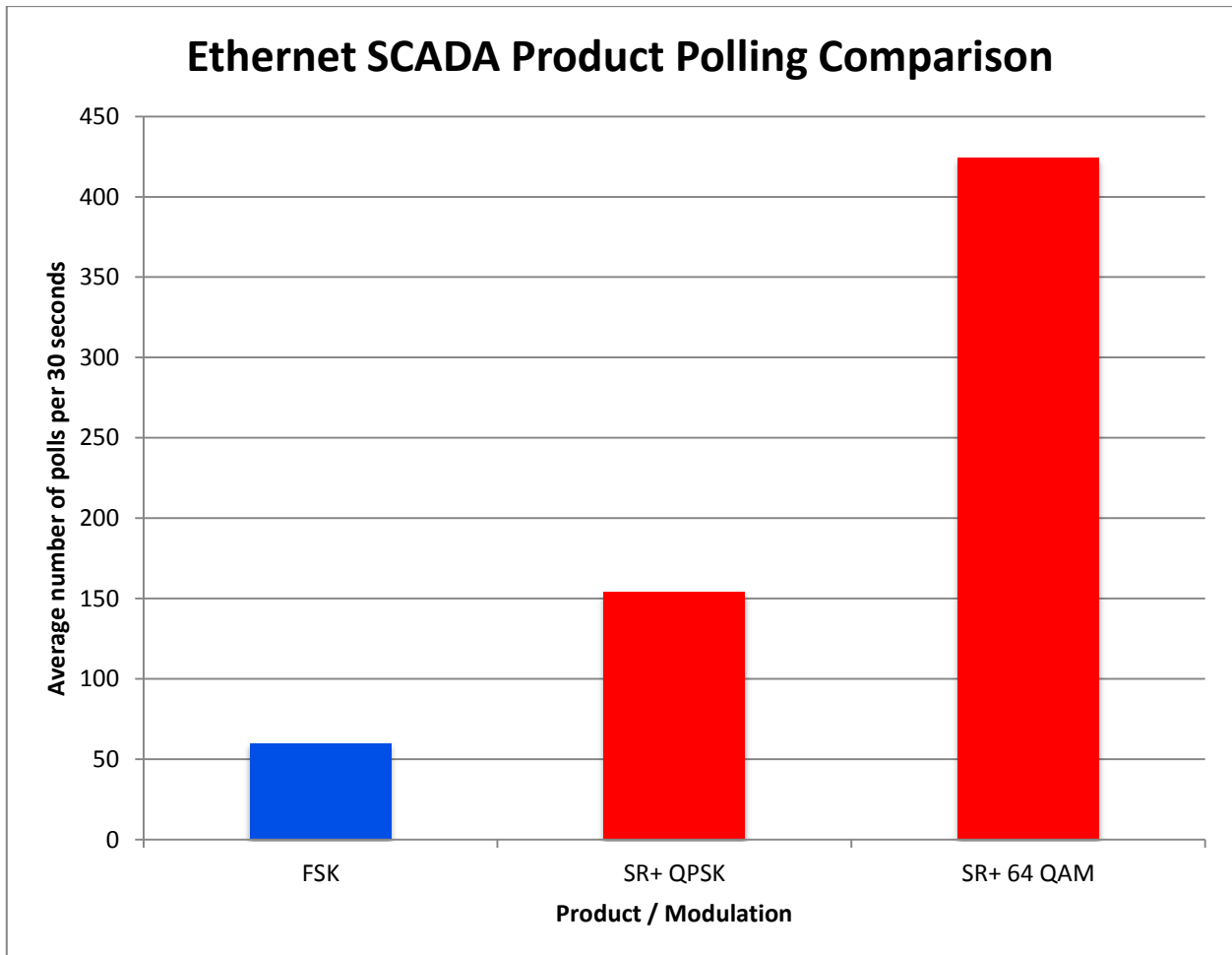
Test 7 Results Table - Mixed Network

Test Number	Description	Result
7	Number of polls within 5 minutes	2460
7	Average number of polls per 30 seconds	246

Test 8 Results Table – Theoretical Predictions from by 4RF R&D

Modulation	Coding	ROHC	13 byte UDP Base to Remote Latency (ms)	260 byte UDP Remote to Base Latency (ms)	Total (ms)	Avg Number Polls per 30 seconds
QPSK	High	No	56	173	229	131
QPSK	High	High	35	161	196	153
QPSK	Low	No	46	139	185	162
QPSK	Low	High	29	126	155	193
64 QAM	Low	No	26	52	78	384
64 QAM	Low	High	24	49	73	410

Summary Graph



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