RipEX – Radio modems

RipEX2

- 1.1 Mbps / 200 kHz / 256QAM
- 4× ETH, 1× SFP, 1× COM, 1× USB,
- RipEX compatible
- All RipEX features plus:
  - 6.25 - 200 kHz channel size
  - ACM, Adaptive FEC
  - RADIUS
  - HW tamper proof
  - Expansion ready - mPCIe
  - Full-duplex ready

RipEX is a **radio modem platform** renowned for overall data throughput in any real-time environment. RipEX radio modems are native IP devices, Software Defined with Linux OS that have been designed with attention to detail, performance and quality. All relevant state-of-the-art concepts have been carefully implemented.

RipEX, 1st generation, is a best-in-class **compact radio modem** proven within the market since 2011 and used in thousands of installations.

RipEX2, 2nd generation, was introduced in 2018. This **more powerful standard radio modem** provides significant improvements, especially in terms of data speed, security and number of interfaces.

RipEX-HS, a **fully redundant** 19' hot-standby **master station** with two radios and two power supplies and available for both, RipEX and RipEX2, is the final member of the RipEX family.

All RipEX devices provide a **24/7 reliable service for mission-critical applications** like SCADA & Telemetry for Electric and Water Utilities, Oil & Gas distribution and many other applications.

RipEX

- 166 kbps / 50 kHz / 16DEQAM
- 1× ETH, 2× COM, 1× USB
- Solar ready
- 0.1 – 10 watts
- - 40 to +70 °C
- WiFi management
- Customized protocols
- Backup routes
- Fast remote access
- IPsec

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General overview
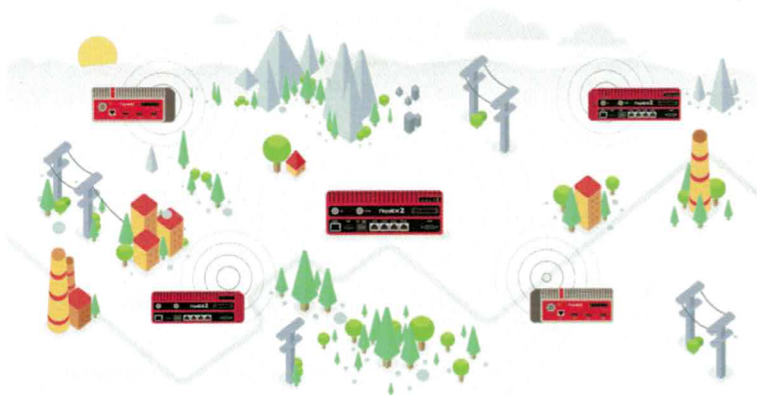
	RipEX	RipEX2
Max. Gross data rate	166 kbps	1.1 Mbps
Gross data rate / 25 kHz	83 kbps	167 kbps
Interfaces	1x ETH, 2x COM, 1x USB	4x ETH, 1x SFP, 1x COM, 1x USB
IPsec	Yes	Yes
RADIUS	No	Yes
Modulations	CPFSK - 16DEQAM	CPFSK - 256QAM
Channel size	6.25 - 50 kHz	6.25 - 200 kHz
Stream mode	Yes	No

Native IP device

Bridge mode – uses a **Transparent protocol** on the Radio channel, i.e. packets received on any interface are broadcast to the respective interfaces on all units in the network. Packets received on COM are broadcast to all COM's at all remote sites, allowing you to connect more RTU's to each remote unit.

Router mode – RipEX works as a standard IP Router with all interfaces (Radio and 1-5 Ethernets) and 1-2 COM ports without any compromise. Each of the five Ethernet ports on RipEX2 can be configured either as a switch or a router. There is an option of two protocols on
the Radio channel: **Flexible** – unlimited anti-collision meshing without base stations or **Base driven** where all packet transmissions are managed by the local base station.

- **Switch** – switched or routed Ethernet ports (RipEX2)
- **Terminal server** - Serial-Ethernet converters, 5 independent sessions
- **TCP proxy** - converts TCP to UDP, eliminates transfer of TCP overhead
- **ARP proxy** - any IP address simulating (for RTU's without routing capabilities within the same subnet)
- **Subnets** - unlimited number of virtual Ethernet interfaces (IP aliases)
- **VLAN** - unlimited number of VLANs assigned to Subnets
- **NAPT** - many IP addresses behind RipEX can be mapped to one RipEX IP
- **GRE** - non encrypted end-to-end tunnel

Data speed & Throughput

- **Possible Network throughput** is **achieved** by
  - **Min. Rx/Tx switching** and synchronization times
  - Optimum **Radio protocol** for the application
  - **Optimization**
    - payload data and headers compression
    - packet flow optimization on Radio channel
- Different data speeds for individual links
- **Auto-speed** - receiver is automatically adjusted to the data rate of the incoming frame
- **ACM** and **Adaptive FEC** (RipEX2)
- **Stream mode** - transmitting starts immediately on the Radio channel, without waiting for the end of the received frame on COM => zero latency

Channel size	Gross data rate		Possible Network throughput	
	RipEX	RipEX2	RipEX	RipEX2
6.25 kHz	21 kbps	42 kbps	> 25 kbps	> 50 kbps
12.5 kHz	42 kbps	83 kbps	> 50 kbps	> 100 kbps
25 kHz	83 kbps	167 kbps	> 100 kbps	> 200 kbps
50 kHz	167 kbps	333 kbps	> 200 kbps	> 400 kbps
100 kHz	–	555 kbps		> 700 kbps
150 kHz	–	925 kbps		> 1.1 Mbps
200 kHz	–	1.1 Mbps		> 1.4 Mbps

Security & Integrity

- **Licensed** radio **bands**
- **FEC**, interleaving, proprietary data compression
- **CRC32** data integrity control on Radio channel
- **Proprietary protocol** on Radio channel
- **Backup routes**
- **Digitally signed FW** (RipEX2)
- **Management** - https, ssh,
- **Role-based access control**
- **AES256** encryption
- **IPsec** - encrypted end-to-end tunnel
- **Firewall** - Layer 2 – MAC, Layer 3 – IP, Layer 4 – TCP/UDP

Radio protocols

- **Transparent / Bridge**
  - Repeater(s) supported
  - No collision avoidance capability
- **Flexible / Router**
  - Unlimited Tree topology
  - Multi-polling and report-by-exception concurrently
  - Nomadic mode - automatic routing
- **Base driven / Router**
  - Star topology, repeaters supported
  - Optimized for TCP/IP (IEC104)
  - Fair distribution of channel capacity among all remotes

Long range

- One radio hop over **50 km**
- **Line of sight not required**
- Carrier output power **0.1 - 10W**
- Exceptional data **sensitivity**
- **Any unit** can work **simultaneously as a repeater**
- **Unlimited** number of repeaters on the way
- Any IP network can interconnect RipEX units

Reliability

- Units **tested in a climatic chamber** and in real traffic
- **Heavy-duty industrial components**
- Industrial rugged die-cast aluminium case
- IP40 or IP51
- **-40 to +70 °C**
- 3 year warranty

Easy to configure and maintain

- **Web interface** or CLI via SSH
- **All** configuration **parameters within one page**
- **Wizards** - fast and simple setup
- **Non-intrusive management** via USB using either ETH/USB adapter or **WiFi**/USB adapter with DHCP
- **Fast remote access** - only the effective data are transferred over the air, html page downloaded from the local unit
- **External flash disc** - automatic configuration, SW keys and FW upgrade

Diagnostics & Network Management

- **Statistic** logs for interfaces and communication links
- Historical and on-line values displayed in **graphs**
- 20 periods (e.g. days) of **history**
- **Watched values** (RSS, Ucc, Temp, PWR, etc.) also from neighbouring units
- **SNMP v3** including **Traps** and **Informs**
- HW **Alarm input**, HW **Alarm output**
- **Monitoring** – on-line analysis of communication over any of the interfaces

Scalability

SW feature keys
- Advance features only when and where needed
- Router, Speed, COM2, 10W, Backup routes, Master
- **Free Master-key trial** - for 30 days in every RipEX

HW models
- The same HW for Base, Repeater or Remote stations
- Internal GPS module - NTP synchronization (RipEX)
- mPCIe slot for expansion boards (RipEX2) GPS, 4G, 2x RS232, DI/DO…

SCADA protocols

- **Modbus, IEC101, DNP3, PR2000, Comli, DF1, Profibus, Async Link, C24, Cactus, RP570, Slip, Siemens 3964(R), IEC104, DNP3/TCP, Modbus TCP and others**
- SCADA serial protocol addresses are mapped to RipEX addresses
- TCP(UDP) protocols can be handled transparently or using Terminal server or TCP proxy
- Embedded **Modbus RTU / Modbus TCP converter**
- Each packet is transferred as an acknowledged unicast

Backup routes

- **Tested alternative paths** between two RipEX units
- **Automatic switch-over** to backup gateway, if primary route fails due to packet loss or weak RSS
- Backup gateway can be behind Radio or Eth interfaces
- **Unlimited number** of Alternative paths
- **Alternative path priority** assignment

Energy savings

- **Solar ready**
- **Sleep mode** - wake up triggered by Sleep digital input or by internal RTC (RipEX2)
- **Save mode** - wake up by a received packet from Radio channel or by Sleep digital input

RipEX-HS

- **Fully redundant hot-standby master station**
- Fully monitored
- **Automatic switchover** capability on detection of failure
- **Auto toggle** mode periodically switches units regardless of failure
- Two booted-up standard RipEX units inside
- **Switch-over** time < 2 s
- **Two** independent **power supplies**
- One or two antenna connectors
- **Hot swappabble**
- 19″ rack 3U

Base Driven Protocol

Collision free

RipEX

Base Driven protocol is primarily optimized for **TCP/IP (IEC104)**, but it is also suitable for collision networks when a remote **(Hidden remote)** is not to be heard by other remotes and/or different Rx and Tx frequencies are used.

RACOM has **20 years of experience** developing protocols on the Radio channel within narrowband networks. We always used **anti-collision protocols** (branded Flexible protocol) where all units communicate spontaneously competing for the Radio channel against each other with collisions managed.

Many anti-collisions **algorithms** were simulated and **tested, including access request** when the base station reserves time slots based on **request** by remotes. The **results** were still **unsatisfactory**, especially for TCP/IP applications with short SCADA packets where request packet is numbers of collisions increased further.

RACOM developers, in cooperation with Technical University in Prague, found after two years dedicated research that **the only way** to successfully **manage TCP/IP** traffic is a **collision free protocol.**

Why? Because when the **number of collisions exceeds a certain limit** and/or stable response times are required, fully organised and managed traffic makes more efficient use of Radio channel capacity! I.e. remotes can't communicate spontaneously and **everything must be managed** by the local **base station.**

Base Driven protocol provides **optimal data throughput and stability for TCP/IP** applications, especially when high numbers of remotes with wide ranging RSS are connected.

- 1.1 Mbps / 200 kHz / 256QAM
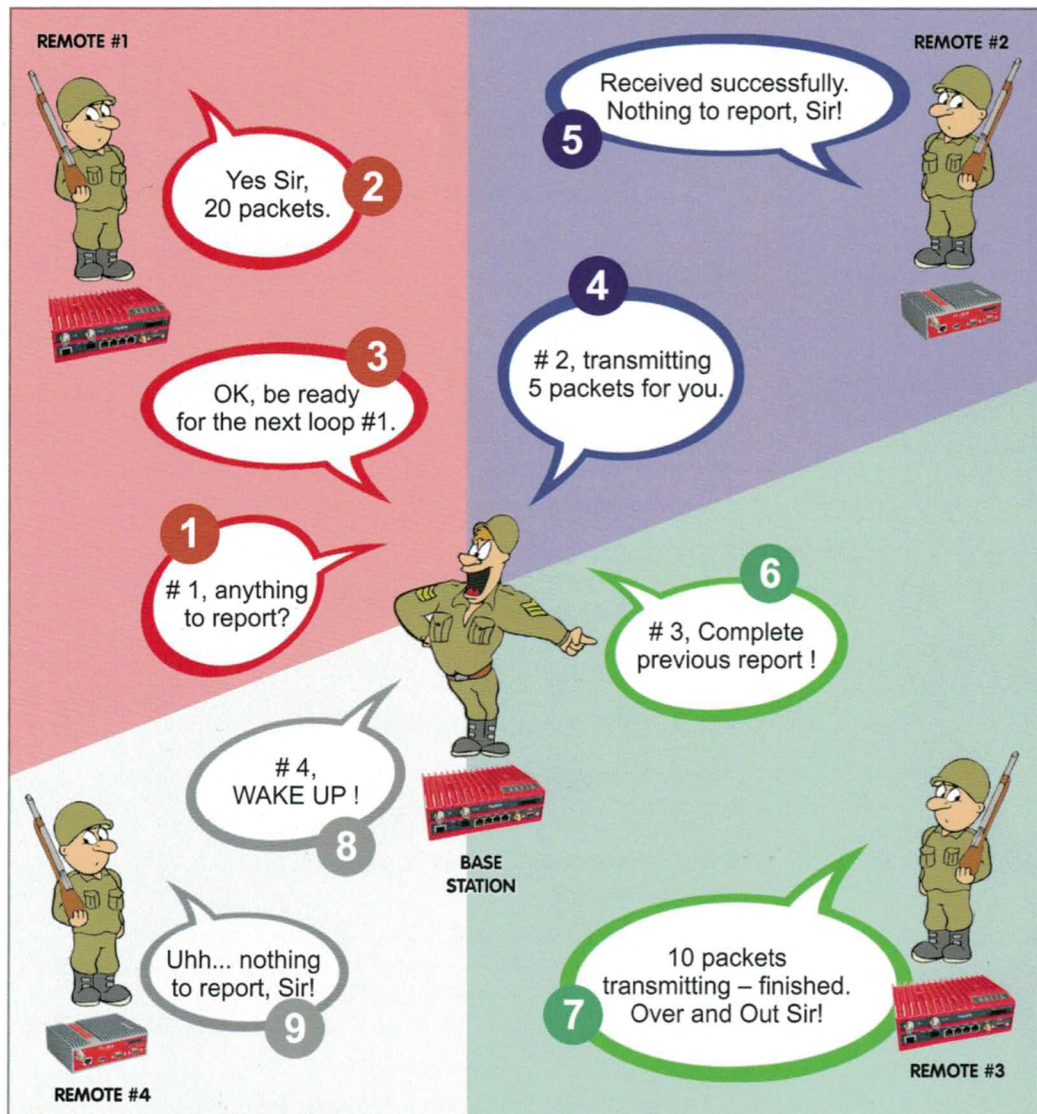- 4×ETH,1×SFP,1×COM,1×USB RADIUS

- 0.1–10 watts, -40 to +70 °
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- 166 kbps / 50 kHz / 16DEQAM
- 1× ETH, 2× COM, 1× USB

RipEX networks

- Future proofed
- Exceptional Data throughput
- Three Radio protocols
- Unlimited RF design
- Backup routes
- Native IP environment
- 3 year warranty

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FEATURES

- **More than 90% of Radio channel capacity dedicated for user data**
- **Designed for Star topology, Repeaters and Hidden remotes supported**
- **Traffic managed and optimized by Base station**
- **There are never collisions in the network**
- **Up to 255 remotes under one Base station**
- **Stable response times with minimum jitter**
- **Fair distribution of channel capacity among all remotes**
- **High reliability - acknowledged unicast packets on Radio channel**
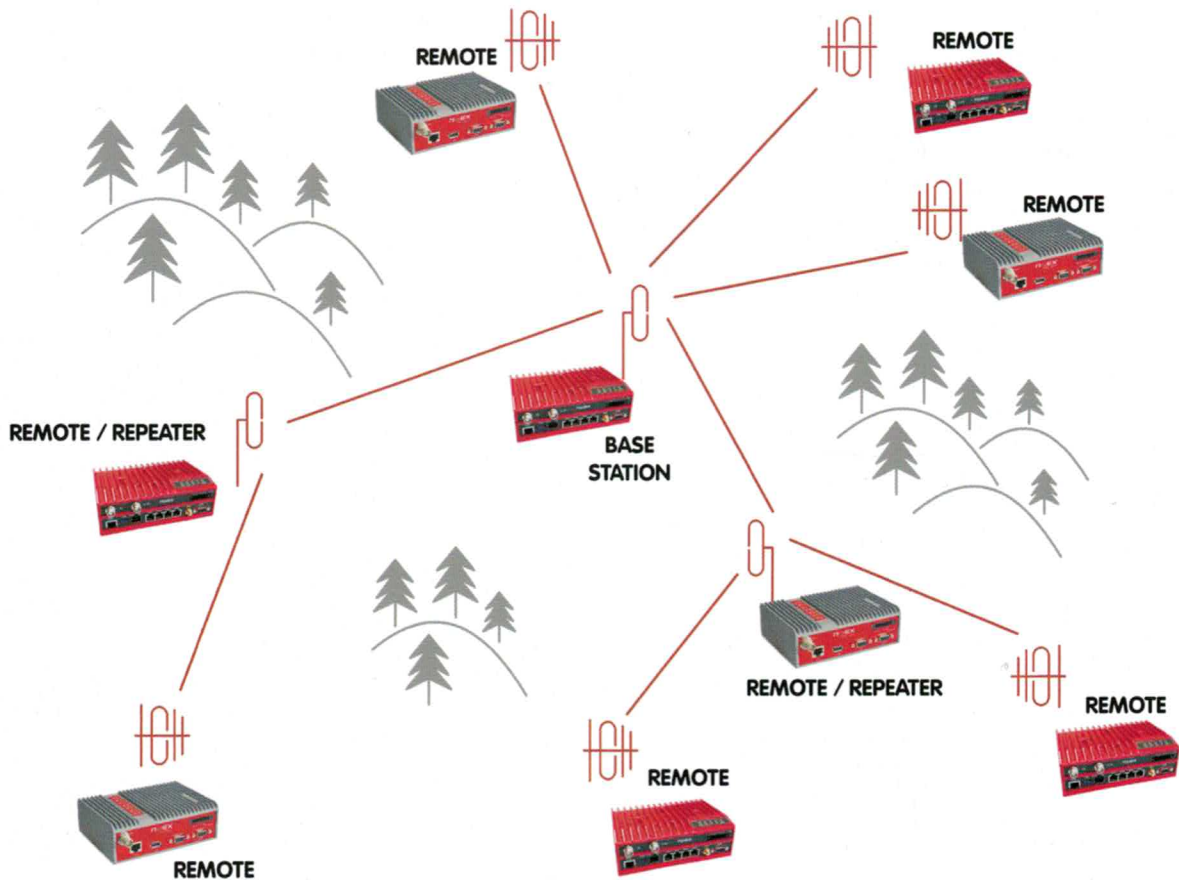
TCP / IP

TCP/IPprotocols like IEC104, used by modern RTUs, create challenging problems because of unstable response times and limited data throughput.

Base Driven protocol Solution:

- TCP/IP transparent
- Optimized for IEC104
- No TCP errors
- No TCP disconnections

Tests confirm that Base Driven protocol handles 5-10x more remotes under one base station and with higher reliability compared to others.

Hidden remotes

Radio protocols using Listen Before Transmit principles, create collisions with 'hidden remotes'. Different Rx and Tx frequencies create the same issues.

Base Driven protocol Solution:

- No collisions even in difficult terrain
- Suitable when different Rx and Tx frequencies are used
- Fair access to Radio channel for all remotes
- Channel capacity distributed fairly amongst all remotes

Base Driven protocol provides significantly higher user data throughput and creates much improved levels of stability and reliability !

ver. 1.2

Flexible Protocol

Unlimited network design

RipEX

Flexible protocol is primarily designed for extensive networks with **unlimited tree topology** and with any number of repeaters and branches. **Each radio** can work as a **base station**, a **repeater**, a **remote**, or all of these **simultaneously**, with **no limits to the number of repeaters** and **way of communication** - any radio can directly communicate with any other.

Thanks to unlimited number of repeaters on the way, **Base stations** strategically positioned at **high points** for maximum footprint coverage are **not needed**. The **communication** can run in **parallel along valleys** with minimal interference which **increases total network throughput**.

Flexible protocol is anti-collision, i.e. **collisions** may occur but are **automatically resolved** by the protocol itself. Flexible protocol is suitable for all types of applications: master or even **multi master-slave polling** and **report by exception** from remotes **concurrently**.

Latest versions of Flexible protocol from RACOM are the result of over **20 years experience** developing anti-collision protocols for narrowband networks. It is the **most effective anti-collision protocol on the market** where proprietary combinations of LBT, CSMA and TDMA are used for Radio channel access. Since **each packet** is transferred as an **acknowledged** unicast, Flexible protocol provides **extreme reliability.**

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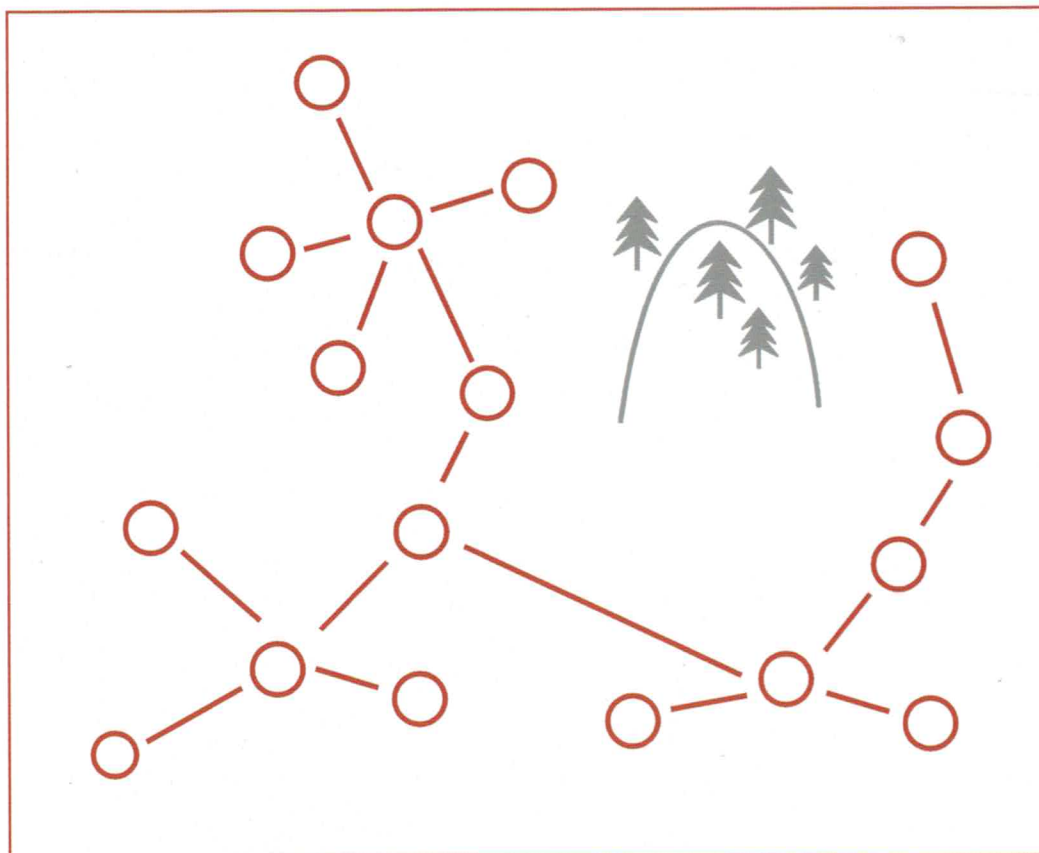- 4×ETH,1×SFP,1×COM,1×USB RADIUS

- 0.1–10 watts, -40 to +70 °
- Solar ready
- Wifi management
- Customized protocols
- Fast remote access
- IPsec

- 166 kbps / 50 kHz / 16DEQAM
- 1× ETH, 2× COM, 1× USB

RipEX networks

- Future proofed
- Exceptional Data throughput
- Three Radio protocols
- Unlimited RF design
- Backup routes
- Native IP environment
- 3 year warranty

FEATURES

- Tree topology with unlimited repeaters and branches
- Standard IP routing
- Collisions automatically resolved
- Bi-directional packet acknowledgement
- Hybrid networks – any IP network can interconnect RipEX units
- (Multi) master-slave polling and report by exception concurrently

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NOMADIC MODE

Nomadic mode is an extension of the Flexible protocol, used for **easy expansion** of an existing network by adding a remote unit (Nomadic Remote). **Routing tables** are updated **automatically** in both, Nomadic Remote and Nomadic Centre.

Nomadic Remote(s) can be transferred to any place within radio coverage and it automatically reconnects to Centre.

Any unit in existing static network can be configured as **Nomadic Base.** Any Nomadic Remote finds **best available** Nomadic Base and **automatically logs** in to Nomadic Centre. Logically, the Routing between Nomadic Base(s) and Nomadic Centre must be set in both directions.

Based on the log in packet, Nomadic Centre automatically updates its Routing table for backward routing and an **IP tunnel** between the Nomadic Centre and Nomadic Remote is created.

The **connection** between the Nomadic Remote and Nomadic Centre is very **stable** and **reliable;** all links between Nomadic Remotes and Nomadic Bases are **periodically checked** and if a better Nomadic Base exists, it is selected.

In case of any problem, e.g. Nomadic Base is out of order, Nomadic Remote automatically switches to the next best available Nomadic Base.

Communication between Nomadic Remote and any other unit is possible via Nomadic Center.

transferable

Best available Base periodic check
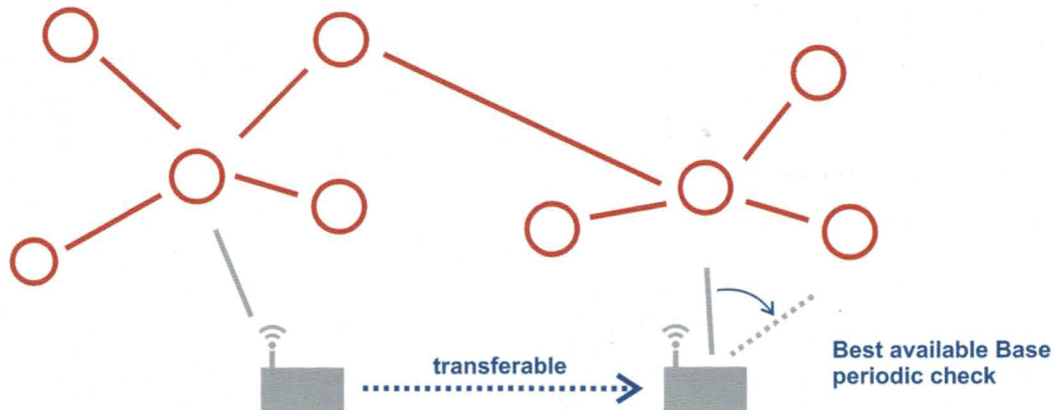
FEATURES

- **Automatic routing between Nomadic Centre and Remotes**
- **Any existing static unit can work as a Nomadic Base station**
- **Nomadic Remotes automatically (re)connect to the best available Base**
- **All packets on Radio channel are acknowledged**
- **Up to 64 Nomadic Remotes under one Nomadic Base**

Network expansion

- **Easy network expansion by adding Nomadic remote**
- **Automatic update of routing table in the Centre.**

Portability

- **Nomadic remote can be transferred**
- **Automatic connection to next Base within a few minutes**

Easy example

- **Bi-directional acknowledged Star**
- **Centre acts as Base**
- **Simply set default gateway**

ver. 1.0

Companies have used SCADA systems for many years and for many different purposes like monitoring systems and maintaining their infrastructure in real time. Many are now finding these **SCADA systems are too old** to meet modern, mission critical requirements and have high maintenance demands; these networks are rapidly coming to the **end of** their effective **lives!**

The optimal solution would be a **phased upgrade** to a modern, **future proofed** radio network using **staged funding** and **available manpower**. This would allow the scaled upgrade to be completed in a well-managed way with **no network outages** in the legacy network.

RipEX was designed to **handle just such a scenario**. Any RipEX unit can be used as a base station and routing tables are used to manage the traffic. Both of these factors enable migration **without** the need to buy expensive **temporary migration hardware.**

The RACOM Migration Solution works equally well for any scenario; whether existing polling or report by exception networks are to be migrated or expanded.

Customer benefits

- **Standard RipEX units used - no expensive temporary migration HW required**
- **Budget investment directed where needed**
- **No network outage during migration**
- **Migration as part of regular maintenance**
- **Gradual one by one replacement**
- **Pay as you grow!**

- **1.1 Mbps / 200 kHz / 256QAM**
- **4×ETH,1×SFP,1×COM,1×USB RADIUS**

- **0.1–10 watts, -40 to +70 °**
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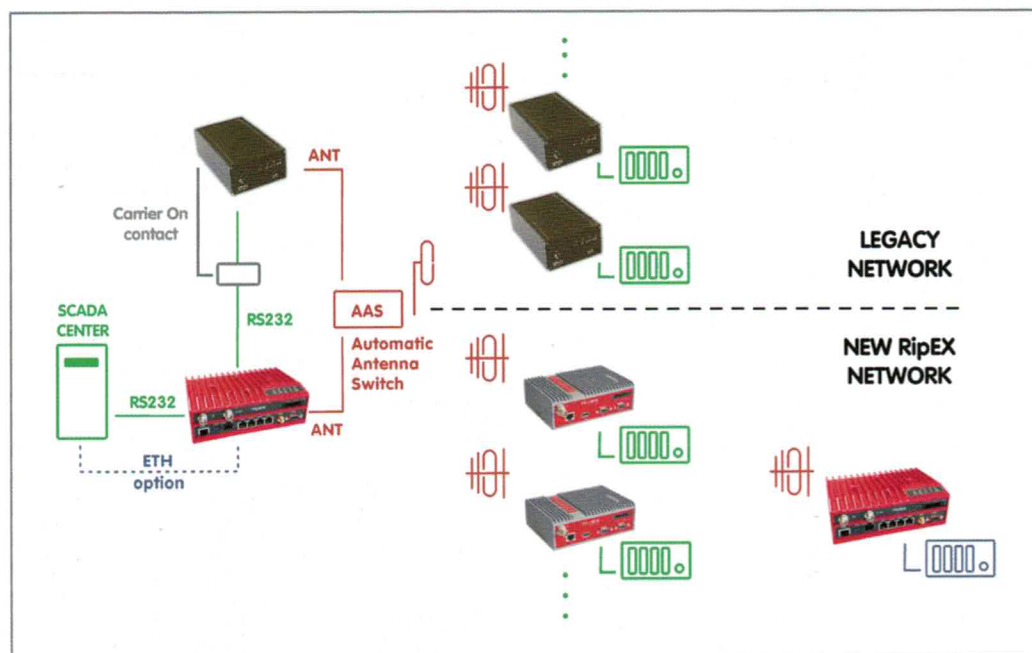
- **166 kbps / 50 kHz / 16DEQAM**
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RipEX networks

- **Future proofed**
- **Exceptional Data throughput**
- **Three Radio protocols**
- **Unlimited RF design**
- **Backup routes**
- **Native IP environment**
- **3 year warranty**

Old network limitations

- Slow data speed
- Obsolete products
- RS232 connections
- Low reliability
- High maintenance costs
- Older protocols

New network demands

- High data throughput
- Future proofed products
- RTU's with Ethernet
- 99.9% uptime
- Low maintenance costs
- Modern IP protocols

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FEATURES

- Same frequency can be used for both networks
- AAS automatically manages antenna switching
- No changes to legacy network required
- RipEX routing table manages traffic for legacy and new network
- HW contact for ´Carrier On´ legacy base station transmissions supported
- Reduced traffic load on legacy network offers improved performance
- Simultaneous SCADA upgrade - Serial and Ethernet RTU´s supported

BENCH TEST

RACOM was invited by a large European utility company to prove the durability of the RACOM Migration Solution. Bench testing was a unique opportunity for RACOM to prove its suitability.
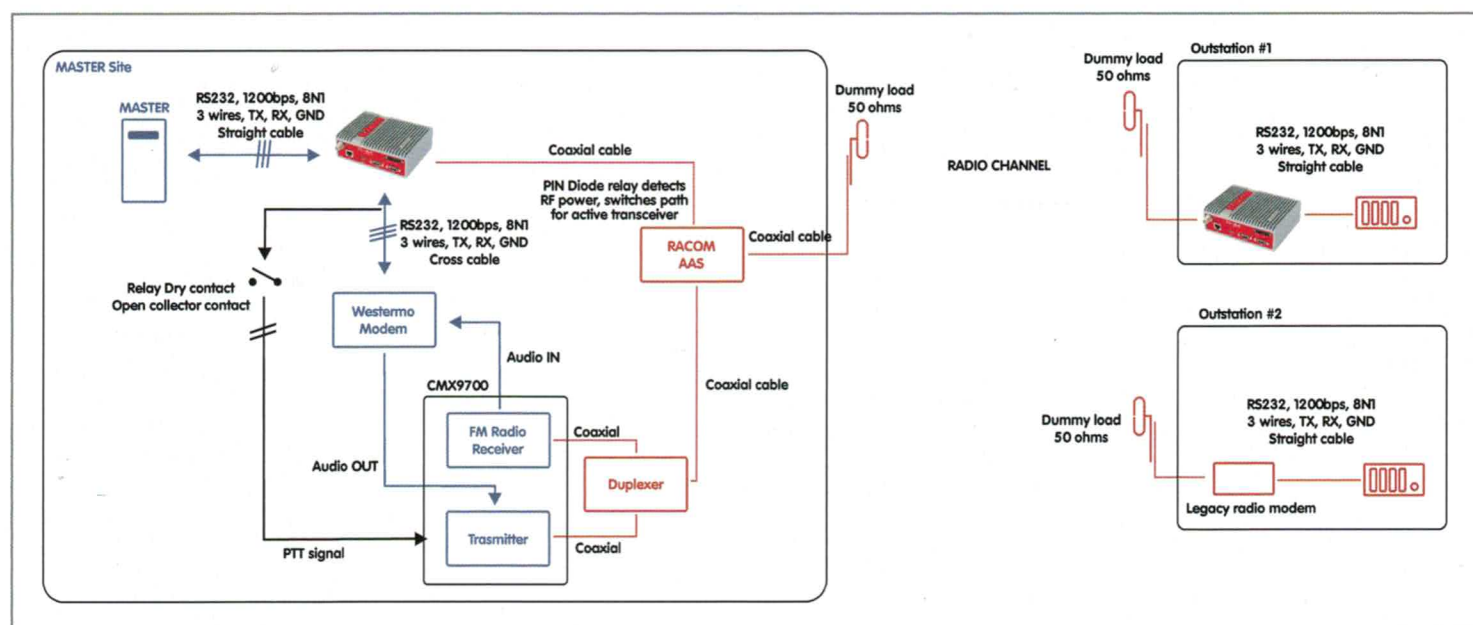
Equipment used in the legacy network included: Clear SCADA SW from Schneider Electric in the centre, Westermo modem + RF datatech radio CMX 9700FD on base stations. There was RF datatech equipment on remotes: URT500 remote telemetry units and CMX9700FD radios with Westermo modems. Medina communication protocol was used for SCADA.

Conclusion

RipEX Migration Solution passed all bench tests successfully at the first attempt!

It was confirmed the RipEX Migration Solution would allow a scaled upgrade to be completed over time in a well-managed way, with no network outages in the legacy network.

RipEX is a best-in-class modem known for reliability, performance and quality, implementing all relevant state of the art concepts and is particularly suitable for systems requiring uninterrupted operation.

Radio parameters	RipEX	RipEX2
Frequency bands	135–154; 154–174; 215-240; 300–320; 320–340; 340–360; 368–400; 400–432; 432–470; 470-512; 928–960 MHz	400–470
Channel spacing	6.25 / 12.5 / 25 / 50 kHz	6.25 / 12.5 / 25 / 50 / 100 / 150 / 200 kHz
Frequency stability	+/- 1.0 ppm	
Modulation	QAM (Linear): 16DEQAM, D8PSK, π/4DQPSK, DPSK FSK (Exponential): 4CPFSK, 2CPFSK	QAM (Linear): 256QAM, 64QAM, 16DEQAM, D8PSK, π/4DQPSK, DPSK FSK (Exponential): 4CPFSK, 2CPFSK
FEC (Forward Error Correction)	On/Off, 3/4	On/Off, 2/3, 3/4, 5/6
Gross data rate	up to 167 kbps	up to 1.1 Mbps
RF Output power	0.1 to 10 W programmable	
Duty cycle	Continuous	
Rx to Tx Time	< 1.5 ms	
Sensitivity	- 99 dBm / 16DEQAM / 25 kHz -115 dBm / 2CPFSK / 25 kHz	- 93 dBm / 256QAM / 25 kHz -115 dBm / 2CPFSK / 25 kHz

Electrical		
Primary power	10 to 30 VDC, negative GND	
Rx	5 W/13.8 V; 4.8 W/24 V; (Radio part < 2 W)	8 W
Tx (dependent on RF power and modulation)	13 – 40 W	13 – 55 W
Sleep mode	0.1 W	0.01 W
Save mode	2 W	5 W

Interfaces		
Ethernet	1x 10/100 Base-T Auto MDI/MDIX / RJ45	4x 10/100 Base-T Auto MDI/MDIX / RJ45
SFP	No	1×10/100/1000 Base-T/1000Base-SX/1000Base-LX
COM 1	RS232 / DB9F 300 – 115 200 bps	RS232/RS485 / DB9F 300 bps – 1 Mbps
COM 2	RS232/RS485 SW configurable / DB9F 300 – 115 200 bps	mPCIe expansion board 2x RS232
USB	USB 1.1 / Host A	USB 3.0 / Host A
Antenna	1x TNC female / 50 ohms (Rx/Tx) or 2x TNC (Rx+Tx) - different HW model	2x TNC female / 50 ohms SW configurable: 1x Rx/Tx or 1x Rx + 1x Tx
Inputs/Outputs	1x HW alarm input, 1x HW alarm output, 1x Sleep input	2x HW alarm input, 1x HW alarm output, 1x Sleep input

Indication LEDs		
LED panel	Power, ETH, COM1, COM2, Rx, Tx, Status	SYS, AUX, RX, TX, COM
ETH	No	4x RJ45 - 2x LED, 1x SFP - 1x LED

Environmental		
IP Code (Ingress Protection)	IP40, IP51	
MTBF (Mean Time Between Failure)	> 900.000 hours (> 100 years)	
Operating temperature	- 40 to +70 °C (- 40 to +158 °F)	
Operating humidity	5 to 95% non-condensing	

Mechanical		
Casing	Rugged die-cast aluminium	
Dimensions	50 H x 150 W x 118 D mm (1.97 x 5.9 x 4.65 in)	60 H x 185 W x 125 D x mm (2.34 x 7.2 x 4.9 in)
Weight	1.1 kg (2.4 lbs)	1.55 kg (3.4 lbs)
Mounting	DIN rail, L-bracket, Flat-bracket, 19" Rack shelf	

SW		
Operating modes	Bridge / Router	Bridge / Router (+Switch)
User protocols on COM	Modbus, IEC101, DNP3, PR2000, Comli, DF1, Profibus, Async Link, C24, Cactus, RP570, Slip, Siemens 3964(R)…	
User protocols on Ethernet	Modbus TCP, IEC104, DNP3 TCP, Comli TCP…	
Serial to IP convertors	Modbus RTU / Modbus TCP, DNP3 / DNP3 TCP, Terminal server	
Radio protocols	Transparent, Flexible, Base driven	
Multi master applications	Yes	
Report by exception	Yes	
Collision Avoidance Capability	Yes	
Remote to Remote communication	Yes	
Repeaters	Store-and-forward; Every unit; Unlimited number	
Optimization	Payload data and Ethernet / IP / TCP / UDP header compression, Packet flow on Radio channel optimization	
NTP (Network Time Protocol)	Client, Server (synchronized from internal GPS)	

Security		
Management	HTTP, HTTPS (own certificate), SSH	
Access accounts	2 levels (Guest, Admin)	4 levels (Guest, Tech, SecTech, Admin) x 3 users
Encryption	AES256	
IPsec	Yes	
RADIUS	No	Yes
Firewall	Layer 2 - MAC, Layer 3 - IP, Layer 4 - TCP/UDP	
HW tamper proof	No	Yes

Diagnostics and Management		
Radio link testing	Yes (ping with RSS, Data Quality, Homogenity)	
Watched values	Device – Ucc, Temp, PWR, VSWR, HW Alarm Input Radio channel – RSScom, DQcom, TXLost [%] User interfaces – ETH [Rx/Tx], COM1 [Rx/Tx], COM2 [Rx/Tx]	
Statistics	For Rx/Tx Packets on User interfaces (ETH, COM1, COM2) User data and Radio protocol (Repeates, Lost, ACK etc.) on Radio channel	
Graphs	For Watched values and Statistics	
History (Statistics, Neighbours, Graphs)	20 periods (configurable, e.g. days)	
SNMP	SNMPv1, SNMPv2c, SNMPv3, SNMP Traps for Watched values	
Approvals	CE (RED), FCC, ATEX, RoHS	Pending

ver. 3.0