APRS
Beyond 2m

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Starting questions

- Who uses APRS anywhere?
- Who uses APRS in RAYNET?
- What bands?
  - HF / 6 / 4 / 2 / 70
- Who “consumes” the information
  - Users?
  - …or just for us?
Why APRS?

What are we trying to achieve?

- APRS is an **information system**
  - Location
  - Messaging
  - Telemetry
  - DF hunting
  - Weather
  - Generic Objects

- But what of these are relevant to RAYNET operations?
Why APRS?

What are we trying to achieve?

For our Users
- Location
- Messaging

Internally
- Location
- Messaging
- Telemetry
APRS

We are going to look at…

- What we mean by “real-time”
- Which frequency
- Trackers
- The network required to make it all work
- Practical examples
- What we learnt along the way
- Hints and tips

Messaging is a whole subject of its own so won’t be covered today
“Real-Time”
Real-Time

- What is “Real time”
  - How often do we need to update?
  - What update rate is actually useful?
- Is it...
  - General overview
  - Nearest km
  - Nearest 100m
Real-Time

<table>
<thead>
<tr>
<th>Event Type</th>
<th>1km</th>
<th>250m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking event</td>
<td>@5k 83m / min</td>
<td>10-15 min</td>
</tr>
<tr>
<td>Marathon</td>
<td>@15k 250m / min</td>
<td>5 min</td>
</tr>
<tr>
<td>Support vehicles</td>
<td>@40-60k 1k / min</td>
<td>1-2 min</td>
</tr>
<tr>
<td>Motorsport</td>
<td>@60-120k 2k / min</td>
<td>30 sec – 1 min</td>
</tr>
</tbody>
</table>

*These assume every beacon gets back to control (we'll come on to that later)*
Real-Time

*It depends on the event requirements*

General overview of progress?
Enough to make resource decisions?
Turn-by-turn for commentary?

*Different Users and resources have different requirements*

Whatever we do, it must be quick enough to be of use to the Users
Which Frequency?
Putting this on 144.800…

Usefulness
- Infrastructure already there
  - RF + Internet
- Easy for your event to be monitored
  - Organisers with iPad

Problems
- Network designed for all flavours of APRS
- Digi locations not ideal (unless you are lucky)
- Other traffic causing lost beacons (75%+)
- Communications channel, not a tracking channel
- Won’t be popular with 1 minute updates!
Other options?

- Add temporary digi’s on 144.800
  - Still have traffic and update speed issues
  - Will be flooded with general traffic
- No restriction using any other frequency
  - UK band-plan is not mandatory
- So, put your own network in for the event!
  - Can update as fast as you like
  - Digi’s where you need them
  - Configuration optimised for RAYNET
Network components

- **You need**
  - Trackers / message terminals
    - Mobile
    - Portable
  - Control
- **Optional**
  - Digipeaters
    - Car/Building-based
    - Hilltop
  - Internet
Trackers
2m & 70cm

- Easy, as APRS-ready radios are available
  - Newer models have GPS built-in
2m & 70cm

- All-In-One devices (usually 2m)
  - Power 500mW to 10w
  - Many include GPS
Any Band…

- Make your own!
  - Simply a radio, tracker & GPS in a case
  - Make up as needed for your requirements
  - Handhelds now available for most bands
Any Band…

- Lots of options
  - TinyTrak, OpenTracker and others
  - Some designed for PCB mounting
  - Just takes a GPS input and sends a beacon
  - Callsign and transmit interval set by software
Any Vehicle...
How we ended up on 4m…

*Started with the Tour of Mull...*

- 21 talk-through’s on 2m & 70cm
- Looking for cheap options
  - Needed at least 10W (so handheld not suitable)
  - 10m  Limited small mobile kit & expensive
  - 6m    Expensive
  - 23cm  Range too limited
- 4m
  - Cheap low-band commercial sets available
  - RATS selling load of Ascom's
  - Under-used band, so little chance of interference
Digipeaters

*Digital Repeaters*
Digipeaters

- Same frequency
- Store & forward
- Intelligent TNC

- Kantronics KPC-3+
- PacComm Tiny-2 / TNC220
- Argent Data Tracker3
- TNC-X
- Microsat
- Raspberry PI / Beagle / Arduino
- …plus others
Digipeateer placement

- Need to cover wide areas
- Don't assume they need to be in the same place as voice TT's
- Consider hill-top in waterproof box
  - Small battery (24Ah)
  - Tripod mast & antenna
  - Easy for two to carry
Digipeater placement
Digipeater placement
Digipeater placement

*Co-site with voice TT’s*

- Different band – OK (but watch harmonics)
- Same band – With separation
  - 150m minimum to avoid desense
- Same band – Close proximity
  - Needs filtering
  - 70cm easy with a cavity duplexer
  - Other bands difficult due to lack of frequency separation
Presenting it to the Users
Presenting it to the Users

How to display the information
- 2nd monitor
- Projector
- Multiple PC's

Careful of callsign confusion
- Users don’t understand them
- Ideal if you can translate them in the software
- Or change tracker callsign to operational call
Presenting it to the Users
Presenting it to the Users
The Internet

…and using it to help you
The Internet

- Simple level
  - Pass everything RX at control onto the internet
  - Easy event monitoring via aprs.fi etc.

- Complex level
  - Using iGate’s to RX actual beacons and pass via an APRS server to control
  - No bandwidth issues

- Only receiving, so no licence implications
The Internet

- Mobile (3G / GPRS) data easy
  - Data traffic very low and slow
  - Tour of Mull
    - 139,000 beacons received over four days
    - Only 5.9MB

- Building connection might be available
  - Domestic broadband
  - Company / User Service LAN
The Internet

- iGate simple to set up
  - All APRS software has iGate options
  - Stand-alone options
    - Microsat
    - Raspberry PI
    - ...and others

- Control needs a reliable connection
  - Avoid WiFi if possible
Fine-tuning the network
Fine-tuning the network

**Beacon routing**

- Think about WHERE beacons need to go
  - Minimise the amount of repeats required to get to control, and no further
  - This is achieved by configuring the beacon path in the tracker
- Tweaking digi settings
  - Configure distant digi’s so they will pick up local trackers but not repeat other traffic
Fine-tuning the network

*Time-slotting*

- Hidden station / dumb tracker problem
- Stations are set to transmit \{xx\} seconds after the start of the minute
  - Station 1 set to 00 sec
  - Station 2 set to 05 sec
  - …
  - Station 12 set to 55 sec
Fine-tuning the network

*Time-slotting*

- Guarantees **no** other station will be transmitting, so will be heard
- Tour of Mull total beacons lost between mobile and rally HQ
  - Before time-slotting
    - Worst 55%, best 28%
  - After time-slotting
    - 4.8% (and stayed <5% for all subsequent rallies)
Practical Examples
Leicester Marathon

- Classic rural marathon
- Control at one end of a long-thin route
- Voice needs a single talk-through
Leicester Marathon

**The Requirements**

To track:
- Lead, Tail and pickup vehicle (three)

The positions had to:
- Be viewable at Race Control
- Update at a rate sufficient to be useful for commentary and making marshalling decisions
Leicester Marathon

The Problems

- Course needed a talk-through
- TT was cross-band (2/70)
- We only had 2m / 70cm APRS equipment
Leicester Marathon

The Solution

- 2 minute update (max 500m)
- One central digipeater, co-sited with TT System on 70cm
  - Opposite end of the band from the TT link
  - Antenna’s separated
Leicester Marathon

The Solution

[Map of Leicester Marathon with marked points]
Endurance 80

- 80km / 50m endurance hike
- Runs for 24 hours continuous
- Talk-through sites easily accessible
- RAYNET control in a school
Endurance 80

*The Requirements*

- To track:
  - All pick-up vehicles (four)
  - Organiser & SWOT team

- The positions had to:
  - Be viewable at Hike Control
  - Update at a rate sufficient to be useful for making logistics decisions
Endurance 80

*The Problems*

- Event covers a large area
  - Checkpoints net requires four talk-through’s
  - Control in a hole
- Low-band PBR repeater (on 72/85) being used for a wide-area mobiles net
  - Desense risk
Endurance 80

*The Solution*

- 1 minute update (max 1km)
- Four digipeaters
- Cross-band 4m to 70cm for link to control
  - Avoids desense from PBR at control
Endurance 80

The Solution
Tour of Mull
The Best Rally in the World!

Road-based car rally
Consists of:
- 150 cars
- 170 route miles
- Every road is rallied, except the main East & South route
- Runs over 3 legs:
  - 2 night (7pm start) and 1 day (11am start)
- 23 rally hours, 45 elapsed hours
Tour of Mull

*The Best Rally in the World!*

- Significant radio usage
  - Amateur 2m, 70cm & 23cm
  - RAC Motor Sports Association (MSA) 81MHz
  - Low-band Simple UK on 77 & 86MHz
  - Lots of high-band VHF PBR
- From a RAYNET perspective, the most technically complex event anywhere in the country… By a **very** long way!!!
Tour of Mull

*The Requirements*

To track:

- All critical course vehicles (six)
- As many Doctors, Rescue units and Recovery units as possible (seven)

The positions had to:

- Be viewable at Rally HQ
- Update at a rate sufficient to provide a “real-time” view
Tour of Mull

*The Problems*

- Mountainous Granite
- Complex terrain
- Twisty, single-track roads
- Anywhere is a long drive!
Tour of Mull

The Problems

- Island-wide coverage
- Single control point
- Poor RF paths

- 2m & 70cm “full” with the voice net
- Availability of equipment
- All equipment needs to run for 48 hours with little or no intervention
Tour of Mull

**The Solution**

- 35 second update for course vehicles
- 4 minute update for rescue / recovery
- Five digipeaters
- Five iGates
- Everything on 4m
  - Avoid desense from / interference to voice net
  - Unlikely to get desense from low-band MSA as stations won’t be co-sited
Tour of Mull

The Solution

2001 – RF only

2008 – Internet
Tour of Mull

The Solution

2001 coverage compared with 2008
When it gets real…

The information we provide can dramatically change decisions made by our Users

Rally officials were making decisions about when to send in competitive cars, based on the known positions of the lead course vehicles

*In some cases this was before the course vehicles had exited the stage*
When it gets a little too real...

The value of positioning was proven in tragic circumstances during the 2003 Tour of Mull.
Telemetry

How system health information can help you manage the network
Telemetry

- APRS Telemetry beacon contains
  - Analogue values (e.g. voltage)
  - Digital values (e.g. mains fail)

- Most TNCs can send telemetry beacons

- Easy configuration to report voltage
  - Pre-empt battery failures
  - Avoid un-necessary trips to check batteries

- Many trackers also report voltage
Telemetry

Example of voltage
What we learnt

…and how we solved the problems
Problems…

*Don’t accept there will be problems, aim to prevent them and solve any that do occur*

Too many events accept that regularly asking operators to “give the kit a kick” is acceptable

*It’s not*

We are supposed to be providing a professional service to our users
Problems…

- Tracker locking up (poor RF design)
- KPC-3 duplication checking problems
- Older TNC’s generating RFI
- Vehicle power “bounce” causing radios to switch off
- Desense
- Premature battery failures
- GPS issues
Problems…

- Mis-configured trackers
- Mis-configured digipeaters
- Mis-configured GPS’s
- Operators thinking they know better and not setting up equipment as prescribed
Hints & Tips

- **Standardise settings for all equipment**
  - Always use default settings as the baseline

- It's a computer system
  - A lot to "tweak" and get wrong
  - Fully understand the system before the event

- Make sure everyone supplying kit understands event settings are non-negotiable
Hints & Tips

- Don't let anyone "play" on the day
- Pre-configure everything (too much pressure and no time on the day)
- Test everything - never assume it will work
- Have someone responsible for the system on the day
Hints & Tips

- Battery management
  - Keep charged (consider constant float)
  - Carry straps on SLA’s
  - Avoid drop damage
  - Full capacity check (not just voltage) at least once a year, and always before a big event

...remember, on the day you are putting in an event tracking system, not Amateur's experimenting with radio
Analysis…
Analysis…