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RACOM
RADIO DATA NETWORKS

Mobile mode, Diagnostic, ...

MORSE Guide 2

www.racom.eu

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1. Mobile radio network

This network is used for communicating between the center and mobile stations. This is a older version. The new one is described in next chapter.

1.1. Principle of communication

```
                     Base
                  _____
                 |           |
              .| 690FC000 |.
               .  |_____|  .
    Center      .                .       Mobile
  _____     .            .     _____
 |           |       .  |           |
 | 690F8000 |                   .| 690F1001 |                from fw 10.x.x.x
 |_____|                     |_____|
                                                             DGe N1
Ne 1Cn ...Center on      FPe 1Mn        ...Mobile on...             oO
                         1b690FC000 ...address for base selection...  ib690FC000
                         1kFFFFC000 ...mask for base selection...     imFFFFC000
                         1c690F8000 ...address of center...           ic690F8000
                         1p20       ...period of reporting to center..ik20
```
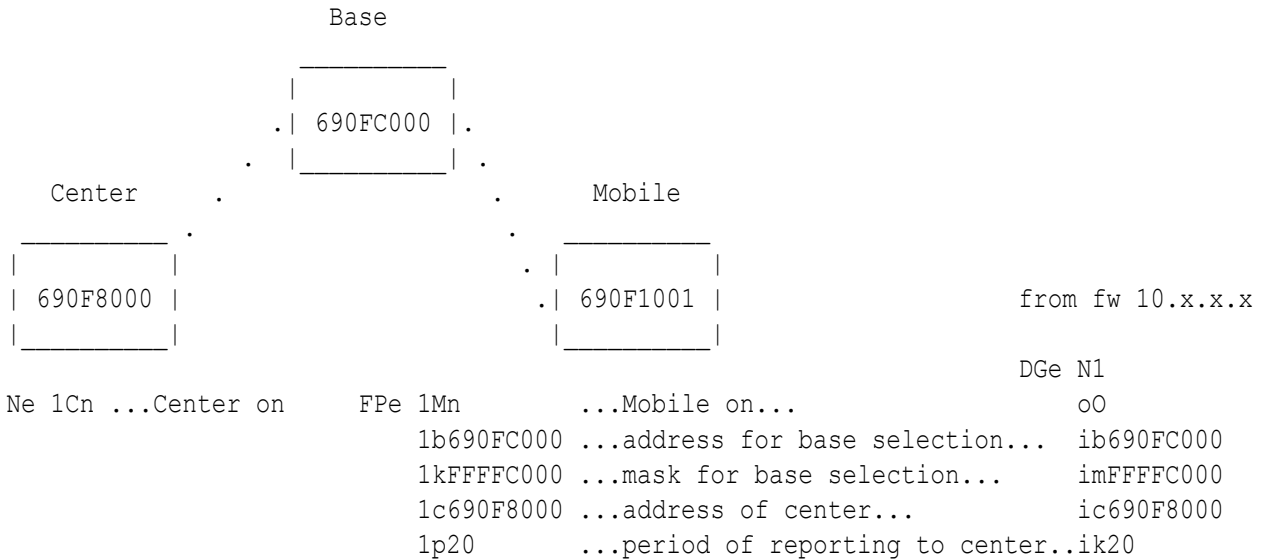
The mobile network contains a Center and the appropriate number of Bases which cover the territory over which the Mobile stations move. The connection between the Center and the Bases can be either direct or indirect using retranslation by means of routing tables. A Mobile station selects the Base station from which it receives the strongest signal and then communicates via this station. The Center records these messages supplemented with information about which Base station the Mobile is available through.

The Mobile makes a selection from stations which it can hear - only those Bases whose addresses, in the range of mask `FPe1k`, correspond to address `FPe1b`. The address of the Center and the period of regular reporting is also defined in the Mobile. If no user communication occurs then the regular message is sent from Mobile to the Center.

Example of regular reporting (monitored by the Base station):

```
Monitoring: source 005AB4B7|5.
15:20:49.9|690FC000 690F1001|690FC000 690F1001|0F3*30* 71 0*90 1mb690F8000
15:20:49.9|690F1001 690FC000|                 |0F3  RFTX  0 06  ack
15:20:49.9|690F8000 690FC000|690F8000 690FC000|0F6  RFTX  0 90 1bc690F1001
15:20:49.9|690FC000 690F8000|                 |0F6*29~ 94 0*06  ack
```

The first report, labelled `mb` at the end, arrives from the Mobile to the Base and carries information that it is determined for the Center with address `690F8000`. Acknowledgement of receipt from the Base then follows.

Another report, labelled `bc`, is sent from the Base to the Center and carries information that Mobile `690F1001` is available to the Center via this Base. Acknowledgement from the Center follows.

1.2. Information stored in the center and in the mobile

It is possible to view the list of currently logged in Mobiles by using the `smc` menu in the Center. The functionality condition for this menu is the restart CU with disconnected service cable.

```
>>sm
Mobile stuff
Center:
(a)ddr:00000000h (m)ask:00000000h
(c)enter status
Mobiles at RF:
 (0) (1) (2) (3) (4)
(q)uit
>>c

>>
Nr   Addr      Base      Timeout  CnfTim
  1  690F1001  690FC000   0289    0304
== send:1  stored:1  mobiles ==
>>
```

Meaning of items:

Nr 1   serial number of Mobile

Addr 690F1001   address of Mobile

Base 690FC000   address of Base through which the Mobile is currently available

Timeout 0289   remaining time of validity of record (sec), after each Mobile login it is set to a value CnfTim, after reaching zero the Mobile is removed from the list

CnfTim 0304   initial time of validity of record, according to menu `Ne1v`

send: 1   number of sent records about listed Mobiles

stored: 1   total number of records stored in the Center

Important

The number of Mobiles registered is limited according to type CU used as Center:

• MR25, MR25ET, MCM302 - 64 Mobiles

• MR400, MR300, MR160, MC100, MG100, MR900 - 450 Mobiles

• SW Walrus - 2000 Mobiles

When the number of Mobiles is high then the `smc` command displayes only part of them `send`. From the overall `stored` list we can select a smaller group using filter `(a)ddr` and `(m)ask` according to the addresses of Mobiles.

Using an `sm1` query in the Mobile, where `1` is the number of the RF channel in mobile mode, we can find out the current state of the Base address and the strength of the signal received from it:

```
>>sm1
Mob
>>
RF protocol HCSMA (Hruska's Carrier Sense Multiple Access)
mobile info on RF channel 1:
RSSI -73 dBm   base 690FC000
>>
```

Calling from the Center to the Mobile then looks as follows:

```
690F8000h>


u S00    690F1001     R01
31/ 75   690FC000     R01
29/ 67   690F8000   serd


 serd    690F8000     R01
30/ 67   690FC000     R01
31/ 75   690F1001   u S00
690F8000h>

Monitoring: source 005A7A1F|1.
12:11.204|690FC000 690F1001|690FC000 690F1001|0E9  RFTX   0 90 4mb690F8000
12:11.244|690F1001 690FC000|                 |0E9*31~ 77  0*06  ack
12:11.282|690F8000 690FC000|690F8000 690FC000|0EA*31* 75  0*90 4bc690F1001
12:11.373|690FC000 690F1001|690FC000 690F1001|0EA  RFTX  10 98 2mb690F8000
12:11.419|690F1001 690FC000|                 |0EA*31~ 76  0*06  ack
12:11.485|690F8000 690FC000|690F8000 690FC000|0EB*30* 75 18*98 2bc690F1001
12:11.502|690FC000 690F8000|                 |0EB*18~ 83  0*06  ack
12:11.558|690FC000 690F8000|690FC000 690F8000|001*31* 75 32*9A 2cb690F1001

12:11.576|690F8000 690FC000|                 |001*31~ 99  0*06  ack
12:11.638|690F1001 690FC000|690F1001 690FC000|0EC*31* 75 40*9A 2bm690F8000
12:11.638|690FC000 690F1001|                 |0EC  RFTX   0 07 mack
```

Monitored in the Mobile using parameter `iMFPe pp = rx (p)romisc. lvl:PACKET`

1.3. Establishing connection

When searching for a connection to the Center the Mobile sends a `cq` packet which contains addresses:

• frm 690FC000 = comparison base for searching for Base

• toa FFFFC000 = mask for selection of Base

Only those stations whose addresses meet the base and mask condition reply. The Mobile then chooses the station with the strongest signal from them and then uses this as the Base. If over a longer period of operation it picks up a stronger signal from another Base it will then start to use that as its own Base and will send this information to the Center.

```
Monitoring: source 004A1E27|1.
RF mon  |toa      frm    |dst       src     |lNo!DQ!RSS size|TT N
12:36.000|FFFFC000 690FC000|                 |000  RFTX   0 03  cq
```

```
12:43.000|FFFFC000 690FC000|                    |000  RFTX   0 03  cq
12:50.000|FFFFC000 690FC000|                    |000  RFTX   0 03  cq
12:51.000|690FC000 690F1001|690FC000 690F1001|490  RFTX   0 90 1mb690F8000
12:51.040|690F1001 690FC000|                    |490*26~ 69  0*06  ack
13:11.000|690FC000 690F1001|690FC000 690F1001|491  RFTX   0 90 2mb690F8000
13:11.040|690F1001 690FC000|                    |491*31~ 69  0*06  ack
```

Monitoring captures the fact that after calling `cq` an `ack` was captured from a suitable Base and then a message was sent through it to the Center.

Monitored in Mobile with parameter `iMFPe pp = rx (p)romisc.lvl:PACKET`

1.4. Configuration

CENTER

As is shown in the initial diagram the function of the Center is defined in menu `Ne` :

```
Nid|address |M | u    s | L   N |l w n g H|sTO Err   Cent vTO hTO
(0) 0053B76D    -  S00|  -  R00|0 0 0 0 -| 15 SERV   OFF 304  30
(1) 690F8000   S00 S00|  -  R01|0 0 0 0 -| 15 SERV   ON  304  30
(2) 00000000   S01 S00|  -  R02|0 0 0 0 -| 15 SERV   OFF 304  30
(3) 00000000   S02 S00|  -  R03|0 0 0 0 -| 15 SERV   OFF 304  30
(4) 00000000   S03 S00|  -  R04|0 0 0 0 -| 15 SERV   OFF 304  30
...
>>1
...
(C)enter:ON e(x)tended:OFF (v)alidity TO:19*16 s (h)istory TO:30
```

Meaning of parameters:

(C)enter:ON	function of mobile operation center switched on
e(x)tended: OFF	for development purposes
(v)alidity TO: 19*16s	time over which the Center considers the record of availability of a Mobile through a certain Base as valid
(h)istory TO: 30 (sec)	after this time packets with the same network number, i.e. repeated packets, which could have arrived through another Base, are discarded. If packets from the Mobile are not numbered it is necessary to set zero here thus eliminating this control step.

BASE

Bases do not require special settings. Their addresses, however, must comply with the conditions set in the Mobile. They must also have a connection to the Center set up either directly or via retranslation using normal routing methods. The Center may also be classified amongst Bases.

MOBILE

The Mobile function in fw **8.x.x.x** and older is defined in menu `FPe` in the respective radio channel:

```
RF channels:
    Access          |ACK              |coding |Mobile
 id a     del l num TO|fix var rep P hT|mod typ|base     mask     center    per
(0) NORMAL 16 16  4 10| 600 400  5   30|REP DBL|OFF
(1) NORMAL 16 16  4 10| 600 400  5   30|REP DBL|690FC000 FFFFF000 690F8000 20
(2) NORMAL 16 16  4 10| 600 400  5   30|REP DBL|OFF
(3) NORMAL 16 16  4 10| 600 400  5   30|REP DBL|OFF
(4) NORMAL 16 16  4 10| 600 400  5   30|REP DBL|OFF
...
>>1
...
 (M)obile mode:ON   (b)ase:690FC000   mas(k):FFFFF000
(c)enter addr:690F8000   (p)eriod:20sec
```

Meaning of parameters:

(M)obile mode:ON	function of mobile RF channel switched on
(b)ase:690FC000	comparison address for selection of Bases
mas(k):FFFFF000	only those stations whose address are comparable with `(b)ase` in the `mas(k)` range can be used as Bases
(c)enter addr: 690F8000	address of mobile operation Center
(p)eriod:20sec	interval of regular reports to Center

The mobile parameters in fw **10.x.x.x** and later are moved into menu `DGe` :

```
Dynamic routing: Globals
m(o)de:MM MOBILE OBSOL
validity (t)imeout:120sec
(N)id:1
Parameters:
mm (m)obile
mm mob(i)le obsol
mm ro(u)ter
mm (b)ase
...
>>i
...
Mobile obsolete mode parameters:
(b)ase:690FC000   (m)ask:FFFFC000   (c)entre:690F8000
(k)eep timeout:20sec
```

Meaning of parameters:

m(o)de:MM MOBILE OBSOL	function of mobile RF channel switched on
(N)id:1	choice the node running in the mobile mode
mm mob(i)le obsol	next parameters:
mm (b)ase:690FC000	comparison address for selection of Bases
mm (m)ask:FFFFC000	only those stations whose address are comparable with `(b)ase` in the `mas(k)` range can be used as Bases
mm (c)entre:690F8000	address of mobile operation Center
mm (k)eep timeout:20sec	interval of regular reports to Center

1.5. Remote acces

REMOTE ACCESS

The Center-Base-Mobile route cannot be simply included in the table route or to the Path packet which is used to create access from a remote CU to the Mobile. If from a remote CU, e.g. `690A0100`, we send a Path packet of the following format:

```
Path32 editor
(c)lear
(h)elp
( 1) 690A0100
( 2) 690F8000
( 3) 690FC000
( 4) 00000000
( 5) 690F1001
( 6) 690F1001
(q)uit
path  690F1001h>!
```

we then achieve the target only assuming that we know the current Base and have included it in the Path packet route:

```
path  690F1001h>

u S02   690A0100    R01
31/ 63  690F8000    R01
30/ 65  690FC000    R01
30/ 64  690F1001   serd

 serd   690F1001    R01
30/ 64  690FC000    R01
31/ 64  690F8000    R01
30/ 68  690A0100  u S02
path  690F1001h>
```

The retranslation packet which came to the Center does not use the principle of mobile route construction. In these cases a configuration with a Network Agent is used creating a so-called tunnel, as is described in a separate article.

1.6. Update from fw 8.x.x.x to 10.x.x.x

Upgrade from fw 8.x.x.x and older to fw 10.x.x.x produce the configuration changes. The menu FPe was cancelled and it's parameters moved to DGe menu (mobile parameters) and FAe menu (radio channel access). It is recommended upgrade together both main module, e.g. E 10.0.62.0 and base module e.g. B 10.0.62.0.

If the upgrade reason is removing the back-up battery problem (see Comment[1] from 1.7.2008) and the configuration changes in the network are difficult, it is possible proceed in this way:

Use the combination of main module serie 8, e.g. E 8.0.11.0 and base module al least B 10.0.45.0, e.g. B 10.0.62.0. Main module of the serie 8 saves the original configuration in FPe menu and base module B 10.0.62.0 together with configuration backup *(c)nf (b)ackup* solves the exhausted battery problem.

This procedure can be safely used for mentioned combination only, so main module serie 8 and base module 10.0.45.0 and later. Older main module, e.g. E 730 can be replaced by newer E 8.0.11.0 and complement it by new B 10.0.62.0.

Note

Updated for version 10.0.86.0

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[1] https://www.racom.eu/eng/support/comments.html

2. Mobile mode SDR

The mobile network provides a connection between the Centre and Mobile stations. It offers plenty of new possibilities compared with the old mobile mode.

```
                        . Base
                     .
                  .
Router . . . Router . . . Base       ...Mobile
  |                       .
  |                       .
Center PLC              Base
```
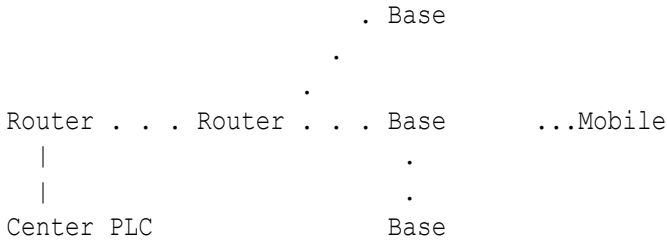
Bases and Routers form the stable part of the network which is connected by standard routing methods. These connections are made over the radio channel or via Ethernet. The central application can be connected to the Router CU or to the Base CU. Communication with a Mobile station then takes place via whichever of the Bases the Mobile station has determined as the most optimum. This choice changes depending on the position of the Mobile station.

All Bases send short packets in regular intervals and the Mobile station selects the optimum Base according to these packets. The Mobile station then sends data packets or maintenance packets via such a Base to the Centre. When the packet passes through the Centre data is recorded into dynamic routing tables in Bases and Routers on the route to the Centre.

The following data packet then travels from the Centre to the Mobile station in accordance with this recorded data. Recorded data is updated each time a packet is sent from the Mobile station.

2.1. Simple example

A simple mobile network contains a Mobile station and two Bases, all connected via radio channels. The central application is connected to one of the Bases. Configuration is derived from default values.

```
  Center
  + Base 1                      Base 2                       Mobil 1
          \|/                           \|/                          \|/
   _____|_                    _____|__                   _____|__
  | 690F0100 |                 | 690F0200 |                 | 690F8001 |
  |_____|                 |_____|                 |_____|


Tw1 p02 n0200               Tw1 p01 n0100


Rpe T4250000                Rpe T4250000                Rpe T4250000
    R4250000                    R4250000                    R4250000
    l7                          l7                          l7
    1 0 111                     1 0 111                     1 0 4250000
    2 0 111                     2 0 111                     2 0 4250000


DGe oB                      DGe oB                      DGe oM
    b b690F8000                 b b690F8000                 m B690F0000
      mFFFF8000                   mFFFF8000                   MFFFF8000
      c690F0100                   c690F0100                   c690f0100
```

- Addresses are selected according to the diagram, see chapter Address allocation.

- Routing tables connect the Bases amongst themselves.

- In menu `Rpe` in Bases the parameters `Rpe 1 0` and `Rpe 1 0` are set to a value of `111`.

- In menu `Rpe` in Mobile the parameters `Rpe 1 0` and `Rpe 1 0` are set to a value of frequency.

- In menu `DGe` in Bases the area of Mobile station addresses is defined by parameters `b, m`.

- In menu `DGe` in the Mobile station the area of Base addresses is defined by parameters `B, M`.

- In all stations the address to which the central application is connected is determined by item `c690F0100`.

For simplicity only radio channels are used in the example. For more complicated networks it is useful to connect the Base via Ethernet, as is show here. A description of the function can be seen in further chapters using both configurations.

2.2. General description

The new mobile mode is used for communication between mobile stations and the control centre. It is configured in menu `DGe`. It differs in a number of ways from the existing mode which was configured primarily from menu `FPe`:

- The mobile station uses not only RSS for selection of an optimum Base, but also other criteria such as DQ or RF channel loading

- A packet in the network is of standard format, which is shorter than the existing special mobile packets

- A Base can contain several modems with various frequencies; the Mobile station tunes into the optimum frequency

- When mounting the Base and Mobile stations with narrowband and wideband modems the Mobile station also selects the most optimum with respect to bandwidth, full-duplex operation is possible

- The principle of dynamic routing which was used up until now in the mobile network Centre has now been extended to all stationary modems

- If there is traffic between the Mobile station and the Centre then maintenance packets are not sent

- If the Base-Centre connection on the ETH channel is interrupted the Base is disabled by switching off the RF channel

2.2.1. Principle of communication

Here we describe a simple situation in the mobile network with a single frequency.

The network contains the necessary number of CU in Router mode which ensure the connection with the CU in the Base function. This connection can be used by channels ETH or RFC. Routing between them is done using standard routing methods. In the network there are also nodes (here 690F0101) which are not in the Router mode. The routing in this nodes contains the directions to Mobiles also.

In each CU between central applications and Bases one of the nodes is labelled as a Router. In base CUs it is labelled as Base and simultaneously performs the function of Router. Router and Base nodes must be selected such that a packet sent in the direction of a Mobile station leaves the CU via this node. A set of possible Mobile stations is defined in these nodes using the parameters `(b)ase` and `(m)ask`. In this way packets which travel to/from the Mobile station are recognised and these packets are processed according to the procedures of dynamic routing.

In the interval `Base info (t)imeout` Bases send a short packet from which Mobile stations collect information about Bases.

Example 1

Diagram of the network with basic parameters

```
                                    DGe oB      ...base mode
                                    b           ...parameters
              other                 Mobile:
              bases                 b690F8000 ...definitions
                :                   mFFFF8000    mobile stations
               :.. BASE 2
                :                   c690F7E05 ...centre
                :                   (e)cho:0   ...base-centre echo timeout
                :   BASE 1          info (t)30 ...base info timeout
                :    _____
                :   | 690F0100 |RFC
               :.ETH| 690F0101 |   .
                :   |_____|    .
                :                    .
   central      :                     .
   ROUTER       :                      .            MOBILE
   _____   :                       .      _____
  |          |  :                   .   |          |
  | 690F00FE |ETH:                RFC| 690F8001 |
  |_____|                       |_____|

DGe oR      ...router mode      DGe oM      ...mobile mode
u           ...parameters       m           ...parameters
Mobile:                         Apps:
b690F8000 ...definitions        b690F7E00 ...definitions
mFFFF8000    mobile stations    mFFFFFE00    aplications

c690F7E05 ...centre via MAS     c690F7E05 ...centre

                                Base:
                                B690F0000 ...definitions
                                MFFFF8000    bases

                                (h)ome:0   ...initial frequency selection
                                (k)eep:30  ...Centre calling interval
```

Mobile stations are in Mobile mode. Using parameters (b)ase and (m)ask a set of possible Base addresses are defined within them. The Mobile station selects the optimum Base according to a number of circumstances. These include:

- captured Base info packet

- pertinence to the set of bases defined above

- loading of base with RF traffic

- RSS and DQ signal from base

- etc.

In the interval `(k)eep timeout` the Mobile station sends a maintenance packet to address `(c)entre` via the selected Base. In all Routers including Bases through which the packet passes the actual route to the Mobile station is stored in dynamic tables in this way. Based on these tables packets are then sent from the central Router (or from other Routers en route) to the Mobile station. The `(c)entre` address is one of a set of addresses of central applications `Apps` defined in the Mobile station by parameters `(B)ase` and `(M)ask`. If a packet is sent from the Mobile station to any of these applications then over the next time interval `(k)eep` a maintenance packet is not sent so as not to increase the density of RF traffic.

Setting Timeout parameters

- `(k)eep timeout` in the Mobile station must be shorter than `validity (t)imeout` in the Base and Router CU, over which time dynamic information about the Mobile station is maintained

- `Base info (t)imeout` in the Base CU must be shorter than `validity (t)imeout` in the Mobile CU, over which time information about the Base CU is kept

- `base-centre (e)cho timeout` has a default value of 0. It is used for a Base connected to the Centre over the ETH channel. When setting non-zero values, for example 10 to 60sec, a ping is sent in this interval to address `(c)entre`. If no response arrives after two pings then RF transmission from this Base is forbidden and the dialog with other Bases on the location is prohibited. This prevents connecting a Mobile station to a Base which is not connected to the Centre. After restoring pings on ETH RFC traffic is renewed.

2.2.2. Overview of basic packets

Monitored at the Base

In the interval `DGebt` the Base sends short packets `base info`. The address `from` is the actual address, information about the loading of RFC of bases is located at address `to` , it doesn´t contain a data packet, packet type is 00:

```
15:18:29.055|C0000000 690F0100|                    |002  RFTX     0 00  bf
```

In the interval `DGemk` the Mobile station sends keep packets to the centre to address `DGemc`. The packet does not contain data, the packet type is 90:

```
15:18:44.939|690F0100 690F8001|690F7E05 690F8001|09A*30* 72    0*90 0dat 0
15:18:44.939|690F00FE 690F0101|690F7E05 690F8001|E00I    IN    0N90 0dat 0
```

This is how an echo packet (!) looks when sent from the Mobile station to the Centre:

```
u S00    690F8001    R01
30/ 82   690F0100     -
   -     690F0101    E00
  E00    690F00FE    serd

 serd    690F00FE    E00
  E00    690F0101     -
   -     690F0100    R01
31/ 80   690F8001  u S00
690F7E05>
```

2.2.3. Information stored in the mobile network CU

CENTRE

Dynamic routing table
(characters of the `rd` command `mrd` need to be written simultaneously)

```
>>mrd

>>Drt: 1 120
d690F8001 t690F0101 q0 113
>>
```

Contains a list of Mobile station addresses which communicated with the Centre and the `to` addresses associated with it via which the Mobile station is reachable. The table is updated after each packet received from the Mobile station. In so doing the validity time set at the end of the row is the default value according to `DGet`, see also information at the end of the row `>>Drt: 1 120`

This table is used in possible other CUs between the central application and Bases. These CUs contains a node in Router mode.

Analogical information is made available by using command `smc`:

```
>>
Nr   Addr      Base      Timeout  CnfTim
  1  690F8001  690F0201    0114     0120
== send:1  stored:0  mobiles ==
>>
```

BASE

Dynamic routing table

```
>>mrd

>>Drt: 3 120
d690F8002 t690F8002 q79 0
d690F8003 t690F8003 q90 0
d690F8001 t690F8001 q81 90
>>
```

The table has the same function as in the case of the Centre. Records about Mobile stations whose timeout has elapsed are also stored in it (maximal 4 Mobiles).

Base table

```
>>mrb

>>Bt: 3 120 dis:0
addr:690F0104 bir:0133 ttl:0.000000
addr:690F0108 bir:0233 ttl:0.000000
addr:690F0100 bir:0033 ttl:107.000000
```

The overwiev of the Bases on the common location (3 Bases working on 3 frequencies here). The summary information on the RF channels load is send into Mobile via a Base info packet.

MOBILE STATION

We obtain an overview of reachable Bases using the command `mrm`:

```
>>mrm

>>Mt: 2 120 TLeft:expired B:690F0100 Dis:0 Rss:-58 Crit:993 DQ:31 FID:0
KLeft:19 Clu:0 Wm:Loc:0.00 Rmt:0.00 Load:rx:0.00;0.00bps tx:0.00;23.99bps
Problem: y:0.000 dy:1.343 TAdren:0

Addr:690F0100 Rss:-58 Dq:31 ttl:113
 33| 00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
993|  .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
  .|  .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
Addr:690F0200 Rss:-87 Dq:31 ttl:98
 33| 00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
983|  .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
  .|  .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
0. Addr:00000000 n:0
1. Addr:00000000 n:0
2. Addr:00000000 n:0
```

Out of the number of debug parameters in the header of the table here we include only:

- `B:690F0100` - selected base

- `Crit:993` - quality criteria of the selected optimum base, the Base having a maximum criteria is choosen

A group of four rows for each location follows. The location is a common place, where works one base or more bases on different frequencies.

The first contains information about the address, Rss, DQ and remaining validity time.

On other rows there is space for recording selective parameters whilst working on more frequencies. One column is reserved for each frequency. Only the first of them is used here. Item `33` characterises Base RF channel loading. Item `993` is the criteria calculated from data about the Base and about the history of the connection.

Brief information is also provided by menu `sm1`:

```
>>sm1

Mob
>>
RF protocol HCSMA (Hruska's Carrier Sense Multiple Access)
mobile info on RF channel 1:
RSSI -58 dBm    base 690F0100
>>
```

Here there is only information about a selected Base and the strength of the signal received from this Base.

2.3. Detailed configuration

The configuration used in the Example 1.

CENTRE

```
Ne:
Nid|address |M | u    s | L    N |l w n g H|sTO Err  Cent vTO hTO
(0) 004B108E    - S00| - R00|0 0 0 0 -| 15 SERV  OFF 304  30
(1) 690F00FE L E00 E00| - E00|0 1 0 0 -| 15 SERV  OFF 304  30
(2) 00000000   S01 S00| - R02|0 0 0 0 -| 15 SERV  OFF 304  30
(3) 00000000   S02 S00| - R03|0 0 0 0 -| 15 SERV  OFF 304  30
(4) 00000000   S03 S00| - R04|0 0 0 0 -| 15 SERV  OFF 304  30
```

If the CU MR400 is used on the Central Router place and the Setr is connected via the service cable then the node 1 configuration looks like:

```
(1) 690F00FE L E00 S00| - E00|0 1 0 0 -| 15 SERV  OFF 304  30
```

```
EIe:
 Channel to Node Interface:
    retranslation   |  user+service          lim
 id N  A t        m | N  A t Base    m  sec brc S   e compr
(0) 1  NO AR        | 1  NO AR          usr OFF NONE
```

```
EPe:
  Internet Protocol:
Eid| ip address            |   net mask           |          gw    |
(0) C0A800FE 192.168.0.254   FFFF0000 255.255.0.0    00000000 0.0.0.0
```

```
0t:
  INTERNET PROTOCOL GATEWAY:
M-IP-M:
  (A)rt:1; write (E)nable:OFF (b)ase:00000000 MAS(K):00000000 s(h)ift:0000
  (r)epeats:0000  Sec(u)rity:OFF  (t)imeout:0  (p)roxy timeout:0s
  (f)rag size:1400bytes  (g)lue (append) up to:0packets
IP-M-IP:
  (I)PArt:0
  b(a)se:C0A800FE  (m)ask:00000000
  IP(F)rag. size:552
MAS:
  (s)Art:4; write (e)nable:ON
  (B)ase:690F7E00  (M)ask:000000FF
```

```
Tw1r:
Wide retab. No 1
01to:0101 02to:0201 03to:0301 7Eto:00FE
```

```
Ar:
ART No 1:
items: 2
default gw: 00000000 (0.0.0.0      )
```

```
dest:    gw:
690F0101 C0A80101 (105.15.1.1      192.168.1.1   )
690F0201 C0A80201 (105.15.2.1      192.168.2.1   )

DGe:
Dynamic routing: Globals
m(o)de:MM ROUTER
validity (t)imeout:120sec
(N)id:1
Parameters:
mm (m)obile
mm ro(u)ter
mm (b)ase


u:
Router mode parameters:
Mobile:  (b)ase:690F8000  (m)ask:FFFF8000  (c)entre:690F7E05
Load treshold: Lo(w)/M-L:200promile  Hi(g)h/H-M:600promile
Load meas (T)au:5000ms  (o)wn load treshold:500bps
debug via (S)ystem channel:OFF
(q)uit
```

BASE

```
Ne:
Nid|address |M | u    s | L    N |l w n g H|sTO Err  Cent vTO hTO
(0) 0048E62D   -  S00| -  R00|0 0 0 0 -| 15 SERV  OFF 304  30
(1) 690F0100    S00 S00| -  R01|0 1 0 0 -| 15 SERV  OFF 304  30
(2) 690F0101    E00 E00| -  E00|0 2 0 0 -| 15 SERV  OFF 304  30
(3) 00000000    S02 S00| -  R03|0 0 0 0 -| 15 SERV  OFF 304  30
(4) 00000000    S03 S00| -  R04|0 0 0 0 -| 15 SERV  OFF 304  30


EIe:
 Channel to Node Interface:
    retranslation    |    user+service           lim
 id N  A t          m | N  A t Base     m  sec brc S   e compr
(0) 2   NO AR       | 2   NO AR          usr OFF NONE


EPe:
  Internet Protocol:
Eid| ip address          |    net mask           |         gw     |
(0) C0A80101 192.168.1.1   FFFF0000 255.255.0.0    00000000 0.0.0.0


0t:
  INTERNET PROTOCOL GATEWAY:
M-IP-M:
  (A)rt:1; write (E)nable:OFF (b)ase:00000000 MAS(K):00000000 s(h)ift:0000
  (r)epeats:0000  Sec(u)rity:OFF  (t)imeout:0  (p)roxy timeout:0s
  (f)rag size:1400bytes  (g)lue (append) up to:0packets
IP-M-IP:
  (I)PArt:0
  b(a)se:C0A80101  (m)ask:00000000
```

```
   IP(F)rag. size:552
MAS:
  (s)Art:0; write (e)nable:ON
  (B)ase:00000000  (M)ask:00000000


Tw1r:
Wide retab. No 1
00to:0101 02to:0101 7Eto:0101


Tw2r:
Wide retab. No 2
00to:00FE 02to:00FE 7Eto:00FE 80to:0100


Ar:
ART No 1:
items: 1
default gw: 00000000 (0.0.0.0        )
dest:    gw:
690F00FE C0A800FE (105.15.0.254    192.168.0.254  )


DGe:
Dynamic routing: Globals
m(o)de:MM BASE
validity (t)imeout:120sec
(N)id:1
Parameters:
mm (m)obile
mm ro(u)ter
mm (b)ase


b:
Base mode parameters:
Mobile:  (b)ase:690F8000  (m)ask:FFFF8000  (c)entre:690F7E05
Base info (t)imeout:30sec  base-centre (e)cho timeout:0sec
Load treshold: Lo(w)/M-L:200promile  Hi(g)h/H-M:600promile
Load meas (T)au:5000ms  (o)wn load treshold:500bps
(D)isable:OFF
debug via (S)ystem channel:OFF


Rpe:
Radio parameters:
(T)X:4432000*100Hz  (R)X:4432000*100Hz
Frequency off(s)et:NONE  :0
Power - (l)evel:A  mW:1697
(c)heck period:30
(1)-tx  (2)-rx
de(f)ault (r)ead (w)rite
(I)nit (S)ync
(q)uit


1:
Allowed TX freqs: (*100Hz)
```

```
(0) :111  (8) :0
(1) :0   (9) :0
(2) :0   (A) :0
(3) :0   (B) :0
(4) :0   (C) :0
(5) :0   (D) :0
(6) :0   (E) :0
(7) :0   (F) :0
(q)uit


2:
Allowed RX freqs: (*100Hz)
(0) :111  (8) :0
(1) :0   (9) :0
(2) :0   (A) :0
(3) :0   (B) :0
(4) :0   (C) :0
(5) :0   (D) :0
(6) :0   (E) :0
(7) :0   (F) :0
(q)uit
```

Mobile mode has a permitted frequency channels defined by items `Rpe 1 0 111` and `Rpe 2 0 111`. An arbitrary non-zero number is sufficient in place of parameter `111`.

MOBILE STATION

```
Ne:
Nid|address |M | u   s | L   N |l w n g H|sTO Err  Cent vTO hTO
(0) 00520E60    - S00| - R00|0 0 0 0 -| 15 SERV  OFF 304  30
(1) 690F8001   S01 S00| - R01|0 0 0 0 -| 15 SERV  OFF 304  30
(2) 00000000   S01 S00| - R02|0 0 0 0 -| 15 SERV  OFF 304  30
(3) 00000000   S02 S00| - R03|0 0 0 0 -| 15 SERV  OFF 304  30
(4) 00000000   S03 S00| - R04|0 0 0 0 -| 15 SERV  OFF 304  30


DGe:
Dynamic routing: Globals
m(o)de:MM MOBILE
validity (t)imeout:120sec
(N)id:1
Parameters:
mm (m)obile
mm ro(u)ter
mm (b)ase


m:
Mobile mode parameters:
Apps: (b)ase:690F7E00  (m)ask:FFFFFE00  (c)entre:690F7E05
Base: (B)ase:690F0000  (M)mask:FFFF8000
(P)assive:OFF  (h)ome frequency id:0
(r)etune timeout:30sec  (k)eep timeout:30sec
(p)ifka timeout:60sec
```

```
Load treshold: Lo(w)/M-L:200promile  Hi(g)h/H-M:600promile
Load meas (T)au:5000ms  (o)wn load treshold:500bps
debug via Event (L)og:OFF
debug via (S)ystem channel:OFF
Retune method parame(t)ers
(q)uit

Rpe:
Radio parameters:
(T)X:4432000*100Hz  (R)X:4432000*100Hz
Frequency off(s)et:NONE  :0
Power - (l)evel:0  mW:25
(c)heck period:30
(1)-tx  (2)-rx

1:
Allowed TX freqs: (*100Hz)
(0) :4432000  (8) :0
(1) :0  (9) :0
(2) :0  (A) :0
(3) :0  (B) :0
(4) :0  (C) :0
(5) :0  (D) :0
(6) :0  (E) :0
(7) :0  (F) :0
(q)uit

2:
Allowed RX freqs: (*100Hz)
(0) :4432000  (8) :0
(1) :0  (9) :0
(2) :0  (A) :0
(3) :0  (B) :0
(4) :0  (C) :0
(5) :0  (D) :0
(6) :0  (E) :0
(7) :0  (F) :0
(q)uit
```

Permitted working channels and the defined frequencies of these channels are given in the menu. In this example there is only one channel.

2.4. General layout of Bases

The mobile network, according to Example 1, used channel ETH for the connection between the central Router and Base. The following example contains the connection over ETH to Base 1 from where the route continues over RFC to Base 2.

Example 2

```
                                DGe oB      ...base mode
                                b           ...parameters
                                Mobile:
                                b690F8000  ...definitions
                                mFFFF8000    mobile stations

                                c690F7E05  ...centre
                                (e)cho:0   ...base-centre echo timeout
                   BASE 1       info (t)30 ...base info timeout
                 _____
                | 690F0100 |RFC -> Mobile
             ..ETH| 690F0101 |  .
             .    |_____|   .
             .                   .
   central   .                   .
   ROUTER    .                   .      BASE 2
 _____  .                   . _____
|         |  .              RFC| 690F0200 |RFC -> Mobile
| 690F00FE |ETH.                |        |
|_____ |  .                |_____|
DGe oR     ...router mode    DGe oB      ...base mode
u          ...parameters     b           ...parameters
Mobile:                      Mobile:
b690F8000  ...definitions    b690F8000  ...definitions
mFFFF8000    mobile stations mFFFF8000    mobile stations

c690F7E05  ...centre         c690F7E05  ...centre
                             (e)cho:0   ...base-centre echo timeout
                             info (t)30 ...base info timeout

             MOBILE

           _____
          |         |
 Base <- RFC | 690F8001 |
          |_____|
      DGe oM      ...mobile mode
      m           ...parameters
      Apps:
      b690F7E00  ...definitions
      mFFFFFE00     applications

      c690F7E05  ...centre
      Base:
      B690F0000  ...definitions  (h)ome:0   ...frequency selection
      MFFFF8000    bases         (k)eep:30  ...Centre calling interval
```

The configuration used is derived from Example 1 with the following modifications:

```
ROUTER
  Tw1: 02 to 0101

BASE 1
  Tw1: 02 to 0200
  Tw2: 02 to 0100

BASE 2
  Tw1: 00 to 0100
       01 to 0100
       7E to 0100
```

Example of an echo packet (!) from a Mobile station via Base 1:

```
690F00FEh>
u S00    690F8001     R01
30/ 69   690F0100      -
   -     690F0101     E00
  E00    690F00FE    serd

 serd    690F00FE     E00
  E00    690F0101      -
   -     690F0100     R01
31/ 69   690F8001  u S00
690F00FEh>
```

Echo packet via Base 2:

```
690F00FEh>
u S00    690F8001     R01
31/ 72   690F0200     R01
31/ 77   690F0100      -
   -     690F0101     E00
  E00    690F00FE    serd

 serd    690F00FE     E00
  E00    690F0101      -
   -     690F0100     R01
30/ 77   690F0200     R01
31/ 72   690F8001  u S00
690F00FEh>
```

Connections between Bases over SCC

There are limited capabilities for use of the SCC channel for connections between Bases (routing to wire). A packet from the Mobile station must record data into dynamic routing tables in the Base or the Router. This packet must enter a node in Base or Router mode via one of the channels RFC, ETH or SCC. However, only one SCC channel can be connected (e.g. SCC3 in menu SIe3rN1 and simultaneously Ne1LS3). This single channel can only continue to one other CU, i.e. it is not possible to branch out using SCC. Example:

```
Router              Base 1          Base 2          Base 3
                                                      \|/
                                      \|/              |
                    \|/                |              0300
                     |               0200-SCC2---SCC3-0301
                   0100-SCC2---SCC3-0201
00FE-SCC2---SCC3-0101
```
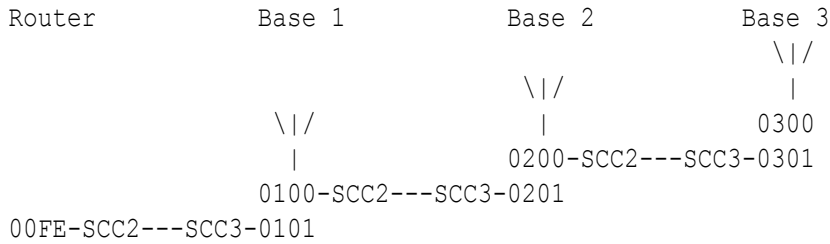
Base and Router functions in dynamical routing

It is possible to create differently configured networks in a similar manner. However, it is important that one node with RFC for mode `MM_BASE` is selected in each Base CU. This node must be the input node on the route from the Mobile stations via the newly configured Base to the Centre. The node has a firmly configured connection to the Central ROUTER CU and to the group of Application addresses in the Centre.

On the route from the Base to the Central router there may be other CUs which are not Bases. In each of them there must be one node (input node in the direction from the Base to the Centre) in `MM_ROUTER` mode. Similar as in the case from the Bases routing to the Central router and to central Applications must be firmly defined from these nodes.

Example:

```
                             . Base 1
Central                  .
Router 1 . . . . Router 2 .              Mobile
                         .
                             . Base 2
```
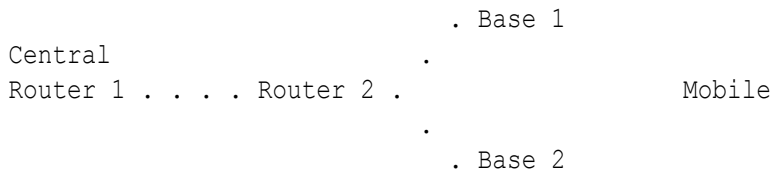
On its journey from the Mobile station via any of the Bases and Router 2 to the Central Router the packet saves records to the dynamic routing tables in the Base, Router 2 and Router 1. The subsequent packet from Router 1 uses the address of the Mobile station as `destination`. According to this `dst` it finds its way in the dynamic routing tables in Router 1, Router 2 and in the Base. The Base 2 provides also the Router function for connection via Base 3.

This is the difference from the existing mobile mode which on the route from the Centre to the Base used the Base as the `dst` address whilst it carried the Mobile station address in the packet header. In the Base the header was then transformed so that the address of the Mobile station moved to the position `dst`.

2.5. Switching Bases

It is possible to use the `mP` function for Base switching tests .

The following example follows on from Example 2. It is also posible to use Example 1 in the same manner.

According to the evaluation of available bases the Mobile station switches to one of them, see menu `mrm` (Mobile station in Example 2):

```
>>mrm

>>Mt: 2 120 TLeft:expired B:690F0100 Dis:0 Rss:-64 Crit:993 DQ:31 FID:0
KLeft:16 Clu:0 Wm:Loc:0.00 Rmt:0.00 Load:rx:0.00;0.00bps tx:0.00;13.07bps
Problem: y:0.000 dy:1.348 TAdren:0

Addr:690F0100 Rss:-64 Dq:31 ttl:111
 33| 00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
993|  .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
  .|  .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
Addr:690F0200 Rss:-88 Dq:31 ttl:102
 33| 00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
979|  .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
  .|  .   .   .   .   .   .   .   .   .   .   .   .   .   .   .

>>!h0fe

690F00FEh>!

690F00FEh>
u S00   690F8001    R01
30/ 82  690F0100     -
   -    690F0101    E00
  E00   690F00FE   serd

 serd   690F00FE    E00
  E00   690F0101     -
   -    690F0100    R01
30/ 64  690F8001  u S00
690F00FEh>
```

The connection to the central Router runs through Base 690F0100.

For testing communication via Base 690F0200 we use function `mP` in the Mobile station. Here we set parameter `Pifka`, which reduces parameter `Crit` of the selected Base and the Mobile station then switches to another Base:

```
>>mP

Pifkas setting:
(a)ddr:690F0100h (t)imeout:300s
(s)et
set (o)thers
```

```
(c)lear all
(q)uit
>>s
```

The result can be seen in table `mrm`:

```
>>mrm

>>Mt: 2 120 TLeft:expired B:690F0200 Dis:0 Rss:-88 Crit:979 DQ:31 FID:0
KLeft:25 Clu:0 Wm:Loc:0.00 Rmt:0.00 Load:rx:0.00;7.29bps tx:0.01;82.59bps
Problem: y:0.000 dy:0.036 TAdren:0

Addr:690F0100 Rss:-64 Dq:31 ttl:115
 33| 00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
248|  .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
296|  .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
Addr:690F0200 Rss:-88 Dq:31 ttl:63
 33| 00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
979|  .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
  .|  .   .   .   .   .   .   .   .   .   .   .   .   .   .   .

>>
```

In the first column of the table for Base 690F0100 the remaining time appeared over which `Pifka` applies, which here is 296 sec. Above this is the significantly reduced criterium for this Base. Switching to Base 690F0200 is the result of this. The Echo packet now passes through Base 690F0200. Address 690F0100 now only performs the function of a dynamic router on the route from Base 690F0200 to the central Router 690F00FE:

```
690F00FEh>!

690F00FEh>
u S00    690F8001    R01
31/ 87   690F0200    R01
30/ 89   690F0100     -
   -     690F0101    E00
  E00    690F00FE    serd

 serd    690F00FE    E00
  E00    690F0101     -
   -     690F0100    R01
30/ 68   690F0200    R01
30/ 88   690F8001  u S00
690F00FEh>
```

Menu `mP` allows Pifka to be cancelled with command `mPc` or to be configured for all other addresses with command `mPo`. The influence of parameter `Pifka` ends once timeout `mPt` has elapsed.

Pifka function in dynamic routing

If faults occur in communication between the Mobile station and any of the Bases the calculated parameter `Problem` grows. If `Problem` exceeds a certain limit (`DGemtP`), parameter `Pifka` is switched to time (`DGemp`) for this Base, and reduces the value of criterium `Crit` contained in table `mrm` according

---

to the set ratio (`DGemtp`). The Mobile station then switches to another Base if available and has a higher value of `Crit`.

2.6. Data packets

Packets carrying user data have the same format as in a standard non-mobile network. The type of packet is 0x09 or 0x89. The address of the Mobile station and Application in the Centre or vice versa are in positions `src` and `dst` in the packet header.

The Mobile station registers packets sent to any application in the Centre with an address according to parameter `DGemb,m`. Over a period `(k)eep timeout` following the sending of such a packet no other `(k)eep` packet is sent to the Centre. On monitoring the Base in example *Mobile 1 - general description* we see that during the period of sending user packets with data `0xAAAA` the transmission of `(k)eep` packets is interrupted.

```
09:45:40.775|690F0100 690F8001|690F00FE 690F8001|23A*31* 66    0*90 0dat 0
09:46:10.683|690F0100 690F8001|690F00FE 690F8001|23B*29* 65    0*90 0dat 0
09:46:36.942|690F0100 690F8001|690F7E01 690F8001|23C*29* 65    2*09 0dat 0
AAAA
09:46:56.889|690F0100 690F8001|690F7E01 690F8001|23D*31* 65    2*09 1dat 0
AAAA
09:47:16.900|690F0100 690F8001|690F7E01 690F8001|23E*28* 65    2*09 2dat 0
AAAA
09:47:36.944|690F0100 690F8001|690F7E01 690F8001|23F*31* 65    2*09 3dat 0
AAAA
09:48:06.694|690F0100 690F8001|690F00FE 690F8001|240*30* 65    0*90 0dat 0
09:48:36.666|690F0100 690F8001|690F00FE 690F8001|241*30* 65    0*90 0dat 0
```

2.7. Watchdog on ETH channel

If in the mobile network according to example *Mobile 1 - general description* Base-Centre communication on the ETH link is interrupted then the Base maintains its radio connection with the Mobile station, however, the Mobile station-Centre connection is non-functional.

For this case it is possible to apply at the Base the function `base-centre (e)cho timeout`. This is activated by inserting the time interval to parameter `DGebe`, e.g. 10 sec. In this interval pings are sent to address Centre (`DGebc`) and the response is monitored:

```
10:10:09.849|690F00FE 690F0101|690F7E05 690F0100|E00I     IN     2N94 4dat 0
0004
10:10:09.850|690F0101 690F00FE|690F0100 690F7E05|E00I     OUT    2n94 4dat 0
8004
```

If a response does not appear twice consecutively then transmission on the RF channel of this Base station is forbidden.

```
10:10:19.849|690F00FE 690F0101|690F7E05 690F0100|E00I     IN     2N94 5dat 0
10:10:19.850|690F0101 690F00FE|690F0100 690F7E05|E00I     OUT    2n94 5dat 0
10:10:29.849|690F00FE 690F0101|690F7E05 690F0100|E00I     IN     2N94 6dat 0
10:10:39.849|690F00FE 690F0101|690F7E05 690F0100|E00I     IN     2N94 7dat 0
10:10:49.849|690F00FE 690F0101|690F7E05 690F0100|E00I     IN     2N94 0dat 0
10:10:59.849|690F00FE 690F0101|690F7E05 690F0100|E00I     IN     2N94 1dat 0
```

This loss in communication on the RFC causes the Mobile station to switch to another Base if it is available:

```
10:09:47.442|690F0100 690F8001|690F00FE 690F8001|26D  RFTX     0 90 0dat 0
10:09:47.531|690F8001 690F0100|                 |26D*31~ 64    0*06  ack
10:10:17.513|690F0100 690F8001|690F00FE 690F8001|26E  RFTX     0 90 0dat 0
10:10:17.602|690F8001 690F0100|                 |26E*31~ 64    0*06  ack
10:10:47.437|690F0100 690F8001|690F00FE 690F8001|26F  RFTX     0 90 0dat 0
10:10:48.698|690F0100 690F8001|690F00FE 690F8001|26F  RFTX d   0 D0r0dat 0
10:10:52.493|690F0100 690F8001|690F00FE 690F8001|26F  RFTX d   0 D0r0dat 0
10:10:54.559|690F0100 690F8001|690F00FE 690F8001|26F  RFTX d   0 D0r0dat 0
10:10:56.619|690F0100 690F8001|690F00FE 690F8001|26F  RFTX d   0 D0r0dat 0
10:10:58.680|690F0100 690F8001|690F00FE 690F8001|26F  RFTX d   0 D0r0dat 0
```

Here it failed to send `(k)eep` packet from the Mobile station which is why parameter `Pifka` appeared in the Mobile station, the value `Crit` dropped for 690F0100 and the Mobile station switched to a second Base 690F0200:

```
>>Mt: 2 120 TLeft:expired B:690F0200 Dis:0 Rss:-84 Crit:991 DQ:31 FID:0
KLeft:2 Clu:0 Wm:Loc:0.00 Rmt:0.00 Load:rx:0.00;0.00bps tx:0.00;19.81bps
Problem: y:0.059 dy:0.510 TAdren:0

Addr:690F0100 Rss:-64 Dq:31 ttl:73
 33| 00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
248| .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
046| .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
Addr:690F0200 Rss:-84 Dq:31 ttl:110
 33| 00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
```

```
991|   .    .    .    .    .    .    .    .    .    .    .    .    .    .    .
 .|   .    .    .    .    .    .    .    .    .    .    .    .    .    .    .
```

Further communication proceeds via Base 690F0200:

```
10:11:17.436|690F0200 690F8001|690F00FE 690F8001|270  RFTX     0 90 0dat 0
10:11:17.526|690F8001 690F0200|                   |270*31~ 86   0*06  ack
10:11:47.448|690F0200 690F8001|690F00FE 690F8001|271  RFTX     0 90 0dat 0
10:11:47.537|690F8001 690F0200|                   |271*31~ 84   0*06  ack
```

After restoring the ETH connection and receiving 2 pings from the Centre the RFC function is restored. The Mobile station may not switch back to the original Base immediately because the switching mechanism avoids frequent switching unless necessary.

2.8. Distribution of addresses

The new mobile mode requires the correct layout of address space, in particular with respect to the potential extension of the network by other participants and other frequencies.

MOBILE STATIONS

The addresses of Mobile stations must be recognisable using an address base and a mask. In the above example they are:

```
base  b 690F8000 (parameter DGeub in Router and DGebb in Base)
mask  m FFFF8000 (parameter DGeum in Router and DGebm in Base)
```

Addresses of Mobile stations can thus take on values:

```
        690F8001
        690F8002
        ...
        690FFFFF
```

Only these src and dst addresses are processed by mobile network dynamic routing.

BASES

Addresses of Bases must also comply with the conditons of the address base and mask, here:

```
base  B 690F0000  (parameter DGemB in Mobile station)
mask  M FFFF8000  (parameter DGemM in Mobile station)
```

This definition of Bases is conditional for the Mobile station for entering captured stations to the list of Bases. In the example Central applications with which the Mobile station communicates also fall into this set. However, these addresses do not work with RFC which is why it is not necessary to eliminate them in a complicated manner from the list of potential Bases.

Other circumstances for the selection of Base addresses is the possibility of mobile network traffic on more frequencies.

The network in the new mobile mode can work with more frequencies. The Mobile station retunes to the frequency of the most suitable Base which is available. Up to 16 CUs (radio modems) with various frequencies can be located at each Base location (station). Each of them can use up to 4 addresses. In our example it only uses 2 addresses - one for RFC and the second for the ETH channel. The recommended diagram of addresses given below reserves address space for all of these possibilities.

Only the lower half of the MORSE address is given in the table. The column represents individual CU located at a station. Each CU has 4 addresses for 4 nodes and one of the frequencies f0 to f15.

```
location 1:
0100 0104 0108 010C 0110 0114 0118 011C 0120 0124 0128...0138 013C  node 1
0101 0105 0109 011D 0111 0115 0119 011D 0121 0125 0129...0139 013D  node 2
0102 0106 010A 010E 0112 0116 011A 011E 0122 0126 012A...013A 013E  node 3
0103 0107 010B 010F 0113 0117 011B 011F 0123 0127 012B...013B 013F  node 4
 f0   f1   f2   f3   f4   f5   f6   f7   f8   f9  f10 ... f14  f15  freq.

location 2:
0140 0144 ...
0141 0145
0142 0146
0143 0147
 f0   f1

location 3:
0180 0184 ...
0181 0185
0182 0186
0183 0187
 f0   f1

location 4:
01C0 ...
01C1
01C2
01C3
 f0

location 5:
0200 ...
 f0

location 6:
.
.
.
location 500:
7DC0 7DC4 7DC8 7DCC 7DD0 7DD4 7DD8 7DDC 7DE0 7DE4 7DE8...7DF8 7DFC  node 1
7DC1 7DC5 7DC9 7DCD 7DD1 7DD5 7DD9 7DDD 7DE1 7DE5 7DE9...7DF9 7DFD  node 2
7DC2 7DC6 7DCA 7DCE 7DD2 7DD6 7DDA 7DDE 7DE2 7DE6 7DEA...7DFA 7DFE  node 3
7DC3 7DC7 7DCB 7DCF 7DD3 7DD7 7DDB 7DDF 7DE3 7DE7 7DEB...7DFB 7DFF  node 4
 f0   f1   f2   f3   f4   f5   f6   f7   f8   f9  f10 ... f14  f15  freq.
```

Related to this breakdown are:

addresses used in the Centre
```
00xx
```

addresses used by Ranec Applications
```
7Exx
```

and User Application addresses
```
7Fxx
```

This breakdown allows the use of a max. of 500 locations, at each of them a max. of 16 CU with 16 frequencies. Routing of such distributed address using routing tables is demanding, as detailed below. This is why in our example the selection has been reduced down to 125 locations and which when using a single frequency forms the series:

```
0100
0200
0300
.
.
7D00
```

For use of all 500 locations it is more preferable to use routing by means of the Hierarchy Routing Table in menu `DHe`, which significantly simplifies the job. HRT allows you to completely forget about using standard routing tables. If the selection of IP addresses according to the needs of the network is also possible then it is also possible to get rid of the ART table.

CENTRE

The Centre in the given example uses 3 groups `wide` from half of the address space `net` reserved for Base :

`690F00xx` - addresses for nodes in the Central Router
`690F7Exx` - addresses used by Ranec applications
`690F7Fxx` - addresses for user Applications

Applications for Ranec and user applications may be connected via MAS. Shared address space for both types of applications is defined in the Mobile station:

```
base  b 690F7E00  (parameter DGmb in Mobile)
mask  m FFFFFE00  (parameter DGmm in Mobile)
```

Packets from the Mobile station to any of the addresses of this space suppress the transmission of a `(k)eep` packet.

2.9. Routing using Hierarchy Routing Table

When the address schema is designed suitably then the HRT can be used instead of the standard routing tables. In this way all the 500 locations mentioned in previous chapter can be utilized easily.

In this mode the node seeks in the HRT for the combination of (b)ase and (m)ask which matches with the destination address. Then creates the address `to` with help of parameteres (t)oa and tm(a)sk and the destination address. For detailed description see the Setr[1] manual.

The tables rTab in Example 1 can be substituted by HRT tables in that way:

CENTRE

```
Ne:
Nid|address |M | u   s | L   N |l w n g H|sTO Err  Cent vTO hTO
(0) 004B108E     -  S00| -  R00|0 0 0 0 -| 15 SERV  OFF 304  30
(1) 690F00FE L  E00 S00| -  E00|0 0 0 0 1| 15 SERV  OFF 304  30
(2) 00000000    S01 S00| -  R02|0 0 0 0 -| 15 SERV  OFF 304  30
(3) 00000000    S02 S00| -  R03|0 0 0 0 -| 15 SERV  OFF 304  30
(4) 00000000    S03 S00| -  R04|0 0 0 0 -| 15 SERV  OFF 304  30


DHe r 1:
Hierarchy Routing Table
    (b)ase    (m)ask    (t)oa    tm(a)sk
(0) 690F0000 FFFFFF00 690F00FE 00000000  ...for centre addresses
(1) 690F7E00 FFFFFF00 690F00FE 00000000  ...for applications behind MAS
(2) 690F0000 FFFF8000 00000001 FFFFFFFC  ...for Base addresses
(3) 00000000 FFFFFFFF 00000000 00000000
(4) 00000000 FFFFFFFF 00000000 00000000
```

The row (2) creates address `to` for the arbitrary Base. It is not required to add next items like in rTab.

BASE

```
Ne:
Nid|address |M | u   s | L   N |l w n g H|sTO Err  Cent vTO hTO
(0) 0049D007     -  S00| -  R00|0 0 0 0 -| 15 SERV  OFF 304  30
(1) 690F0100    S00 S00| -  R01|0 0 0 0 1| 15 SERV  OFF 304  30
(2) 690F0101    E00 E00| -  E00|0 0 0 0 2| 15 SERV  OFF 304  30
(3) 00000000    S02 S00| -  R03|0 0 0 0 -| 15 SERV  OFF 304  30
(4) 00000000    S03 S00| -  R04|0 0 0 0 -| 15 SERV  OFF 304  30


DHe r 1:
Hierarchy Routing Table
    (b)ase    (m)ask    (t)oa    tm(a)sk
(0) 690F0000 FFFF8000 690F0101 00000000  ...for centre, MAS, Base
(1) 00000000 FFFFFFFF 00000000 00000000
(2) 00000000 FFFFFFFF 00000000 00000000
(3) 00000000 FFFFFFFF 00000000 00000000
(4) 00000000 FFFFFFFF 00000000 00000000
```

---

[1] https://www.racom.eu/eng/support/firmware/mr400/sdr.html

```
DHe r 1:

Hierarchy Routing Table
    (b)ase    (m)ask    (t)oa     tm(a)sk
(0) 690F0000 FFFF8000 690F00FE 00000000   ...for centre, MAS, Base
(1) 690F8000 FFFF8000 690F0100 00000000   ...for Mobiles
(2) 00000000 FFFFFFFF 00000000 00000000
(3) 00000000 FFFFFFFF 00000000 00000000
(4) 00000000 FFFFFFFF 00000000 00000000
```

All functions in the mode Mobile SDR works at HRT identically like at using rTab.

2.10. Conversion of IP addresses by masking

If it is possible choose the IP addresses to be similar the MORSE addresses like in the Example 1, then the conversion can be done using masking instead of by Art tables. Set it in the EPe menu, part M-IP-M using parameters (b)ase and MAS(K). The parameter (A)rt:1 must have a nonzero value to be activated the mode M-IP-M. The Art table can be empty. Set parameters Sec(u)rity:OFF, (f)rag size:1400bytes. This part of menu is set identically in the central Router and in Base.

```
   INTERNET PROTOCOL GATEWAY:
M-IP-M:
(A)rt:1; write (E)nable:OFF (b)ase:690F0000  MAS(K):0000FFFF  s(h)ift:0000
(r)epeats:0000  Sec(u)rity:OFF  (t)imeout:0  (p)roxy timeout:0s
(f)rag size:1400bytes  (g)lue (append) up to:0packets
```

When the network is enlarged in scope of the address diagram we doesn't need add a new items in the Art tables.

2.11. Operation on more frequencies

The Mobile network can be equipped at each location with several base stations with various frequencies. The Mobile station then automatically retunes to the frequency of the one which is most suitable with respect to radio channel loading.

> ⚠ **Important**
>
> Automatic tuning of a frequency requires newer sw in PIC of the radio part of the CU. For MR160 a minimum of 36 and for MR400, MR300 a minimum of 42. Access the sw version number using command Rhe parameter `S(W) ver`.

Base stations are connected amongst themselves and to the central router via the ETH channel. Stations at one location exchange information about each of their levels of RF loading. The aggregate information (base info), containing an overview of RF loading of stations at locations, is sent by each of them on their frequency. One of the frequencies (home) is common for the whole network and covers the whole mobile network territory.

A mobile station collects the message `base info` and according to this maintains an overview of available bases and their RF loading. It then selects from these the optimum base for communication with the central router.

Selection of addresses and frequencies

Base addresses can be selected according to the diagram given in section Address allocation:

```
location 1:
0100 0104 0108 010C 0110 0114 0118 011C 0120 0124 0128...0138 013C  node 1
0101 0105 0109 011D 0111 0115 0119 011D 0121 0125 0129...0139 013D  node 2
0102 0106 010A 010E 0112 0116 011A 011E 0122 0126 012A...013A 013E  node 3
0103 0107 010B 010F 0113 0117 011B 011F 0123 0127 012B...013B 013F  node 4
 f0   f1   f2   f3   f4   f5   f6   f7   f8   f9  f10 ... f14  f15  freq.


location 2:
0140 0144 0148 040C ...
0141 0145 0149 041D
0142 0146 014A 040E
0143 0147 014B 040F
 f0   f1   f2   f3
```

There can be up to 16 stations with various frequencies at one location. One of the frequencies which is common for all locations is labelled as home. Frequencies can follow on from each other in a grid, e.g. 25 kHz, however, this is not conditional. Addresses for node 1 are determined for radio operation, and the other 3 addresses are used as necessary for the ETH channel, etc.

The addresses of Mobile stations must comply with the condition recorded in parameters of Bases and Routers, i.e. here the addresses are in the range from 8000 to FFFF.

Configuration example

Base - configuration amendment

Example 1 is modified for 3 Bases at location 690F0100, which work on frequencies f0, f1, f4.

For 690F0100:

```
Radio parameters:
(T)X:4110000*100Hz   (R)X:4110000*100Hz
Frequency off(s)et:NONE  :0
Power - (l)evel:7  mW:275
(c)heck period:0
(1)-tx  (2)-rx
de(f)ault (r)ead (w)rite
(I)nit (S)ync
(q)uit
>>
1
Allowed TX freqs: (*100Hz)
(0) :111  (8) :0
(1) :111  (9) :0
(2) :0   (A) :0
(3) :0   (B) :0
(4) :111  (C) :0
(5) :0   (D) :0
(6) :0   (E) :0
```

```
(7) :0   (F) :0
(q)uit
>>
2
Allowed RX freqs: (*100Hz)
(0) :111   (8) :0
(1) :111   (9) :0
(2) :0   (A) :0
(3) :0   (B) :0
(4) :111   (C) :0
(5) :0   (D) :0
(6) :0   (E) :0
(7) :0   (F) :0
(q)uit
>>
```

For 690F0104 there is only a difference in menu Rpe for the set frequency:

```
Radio parameters:
(T)X:4110250*100Hz  (R)X:4110250*100Hz
```

For 690F0110 the frequencies are:

```
Radio parameters:
(T)X:4111000*100Hz  (R)X:4111000*100Hz
```

Menu Rpe1 - Allowed TX freqs:

In the menu the Bases to a common location are labelled with non-zero items, and in this case 111. The CU works out their addresses according to the address diagram:

```
channel  address
 (0)    690F 0100
 (1)    690F 0104
 (4)    690F 0110
```

Their frequencies are not important for communication between Bases, because this is done over Ethernet.

Mobile station - configuration amendment

Menu Rpe 1

```
Allowed TX freqs: (*100Hz)
(0) :4110000  (8) :0
(1) :4110250  (9) :0
(2) :0   (A) :0
(3) :0   (B) :0
(4) :4111000  (C) :0
(5) :0   (D) :0
(6) :0   (E) :0
(7) :0   (F) :0
```

Menu Rpe 2

```
Allowed RX freqs: (*100Hz)
(0) :4110000  (8) :0
(1) :4110250  (9) :0
(2) :0   (A) :0
(3) :0   (B) :0
(4) :4111000  (C) :0
(5) :0   (D) :0
(6) :0   (E) :0
(7) :0   (F) :0
```

Setting up frequencies is similar for all mobile stations in the network. In the Rpe menu it is not necessary to set up the working frequency (T)X: or (R)X:. However, it is necessary in menu Rpe1 to record all Tx frequencies used and in menu Rpe2 all Rx frequencies used.

Functions

Bases send packets to the addresses of other Bases at the same location. These pass on information about their active status and about RF channel loading. The loading is expressed as a number:

```
33 - low load, lower than parameter DGebw set in the Base
22 - medium load, between DGebw and DGebg
11 - high load, higher than DGebg
```

In duplex stations loading of the Tx and Rx channel is distinguished, for example 32.

The resulting information at the location with three Bases is available by using command mrb:

```
>>Bt: 3 120 dis:0
addr:690F0110 bir:0433 ttl:106.000000
addr:690F0100 bir:0033 ttl:119.000000
addr:690F0104 bir:0133 ttl:120.000000
>>
```

The record contains:

```
addr:690F0110    Base address
bir:0433         04 - channel number
                 33 - level of RF channel loading
ttl:106.000000   106 sec - remaining validity time
```

The aggregate information is sent for Mobile stations over the RF channel. These `base info` packets are short, do not contain data, and information is stored at the place of `to` address:

```
>>
RF mon     |toa      frm    |dst      src     |lNo!DQ!RSS size|TT N
12:18:33.073|F0C00000 690F0100|                 |000  RFTX     0 00  bf
```

The Mobile station receives base info packets and compiles an overview of available Bases from them. The example contains one location with three Bases on frequency channels f0, f1, f4 with addresses 690F0100, 690F0104, 690F0110:

```
>>mrm

>>Mt: 1 120 TLeft:expired B:690F0100 Dis:0 Rss:-67 Crit:754 DQ:6 FID:0
```

```
KLeft:5 Clu:0 Wm:Loc:0.00 Rmt:0.00 Load:rx:0.00;0.00bps tx:0.00;1.44bps
Problem: y:0.000 dy:1.726 TAdren:0


Addr:690F0100 Rss:-67 Dq:6 ttl:118
 33| 33| 00  00  33! 00  00  00  00  00  00  00  00  00  00  00
754|754|  .   .  754!  .   .   .   .   .   .   .   .   .   .   .
  .|  .|  .   .   .!  .   .   .   .   .   .   .   .   .   .   .
>>
```

The other example contains two locations,
at one addresses 690F0100 with frequency f0 and 690F0104 with frequency f1,
at the second location there is address 690F0200 with frequency f0:

```
>>Mt: 2 120 TLeft:expired B:690F0104 Dis:0 Rss:-66 Crit:988 DQ:30 FID:1
KLeft:30 Clu:0 Wm:Loc:0.00Rmt:0.00 Load:rx:0.01;82.91bps tx:0.00;63.82bps
Problem: y:0.007 dy:0.882 TAdren:0


Addr:690F0100 Rss:-66 Dq:30 ttl:120
 33| 33| 00  00  00  00  00  00  00  00  00  00  00  00  00  00
988|988|  .   .   .   .   .   .   .   .   .   .   .   .   .   .
  .|  .|  .   .   .   .   .   .   .   .   .   .   .   .   .   .
Addr:690F0200 Rss:-77 Dq:30 ttl:67
 33| 00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
987|  .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
  .|  .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
```

According to parameter Crit the Mobile station selects the optimum Base, retunes to its frequency, and communicates via this Base with the central Router.

2.12. Overview of communication

Exchange of information between Bases about loading of their radio channels.

The group of Bases at each location mutually informs itself about loading of its RF channels. The result is recorded in each Base.

RFC load info
result recorded in Base:

```
>>mrb

>>Bt: 2 120 dis:0
addr:690F0104 bir:0133 ttl:118.000000
addr:690F0108 bir:0033 ttl:116.000000
>>
```

```
>>mrb

>>Bt: 3 120 dis:0
addr:690F0200 bir:0033 ttl:116.000000
addr:690F0204 bir:0133 ttl:117.000000
addr:690F0208 bir:0233 ttl:117.000000
>>
```

Transmission of aggregate information about Bases for Mobile stations.

Aggregate information about loading of individual RFC at a location is sent by each Base on its frequency. The Mobile station creates an overview about all locations from which it hears any Base.

result recorded in Mobile:

```
>>mrm

>>Mt: 2 120 TLeft:18 B:690F0208 Dis:0 Rss:-68 Crit:992 DQ:31 FID:2
KLeft:18 Clu:0 Wm:Loc:0.00 Rmt:0.00 Load:rx:0.00;0.00bps
tx:0.00;24.33bps Problem: y:0.000 dy:0.435 TAdren:0

Addr:690F0100 Rss:-65 Dq:30 ttl:114
 00  33! 33| 00  00  00  00  00  00  00  00  00  00  00  00
  . 988!988|  .   .   .   .   .   .   .   .   .   .   .   .
  .  .! .|  .   .   .   .   .   .   .   .   .   .   .   .
Addr:690F0200 Rss:-68 Dq:31 ttl:108
 33| 33! 33| 00  00  00  00  00  00  00  00  00  00  00  00
992|992!992|  .   .   .   .   .   .   .   .   .   .   .   .
 .|  .! .|  .   .   .   .   .   .   .   .   .   .   .   .
>>
```

Transmission of maintenance packets from Mobile stations to the Centre.

The Mobile station selects the optimum Base and via this sends maintenance packets or data packets to the Centre. Routers and Bases en route record the current direction to the Mobile station into their dynamic routing tables.

result in Router:

```
>>mrd

690F00FEh>Drt: 2 120
d690F8001 t690F0209 q1 99
d690F8003 t690F0105 q1 93
>>
```

result in Base 0208:

```
>>mrd

>>Drt: 1 120
d690F8001 t690F8001 q85 117
>>
```
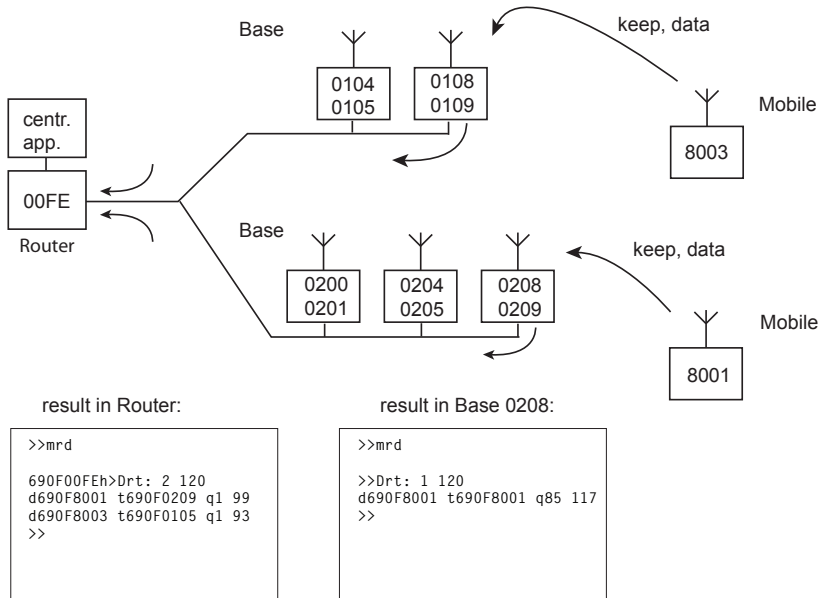
Routing of data packets from the Centre to the Mobile station.

A packet sent from the Central application to a Mobile station is directed in routers and Bases according to dynamic routing tables.

routing solution:

```
>>mrd

690F00FEh>Drt: 2 120
d690F8001 t690F0209 q1 99
d690F8003 t690F0105 q1 93
>>
```

```
>>mrd

>>Drt: 1 120
d690F8001 t690F8001 q85 117
>>
```

```
690F8001h>!

690F8001h>
u S00   690F00FE    E00
  E00   690F0209    -
    -   690F0208    R01
28/ 86  690F8001    serd

  serd  690F8001    R01
30/ 87  690F0208    -
    -   690F0209    E00
  E00   690F00FE  u S00
690F8001h>
```
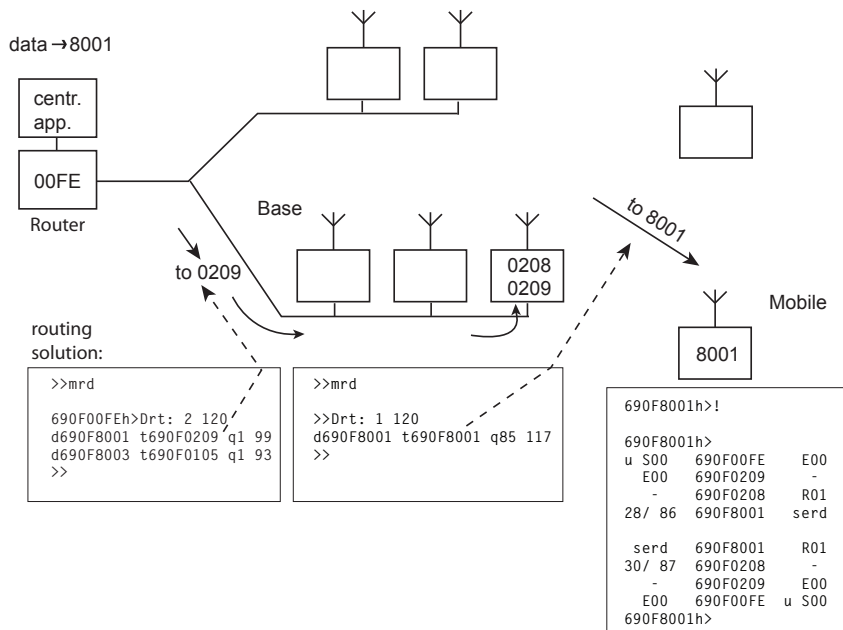
2.13. Overview of parameters for mobile mode

Overview of menu parameters:

- Rpe - setting up frequencies

- DGe - setting up mobile mode

- m - parameters for diagnosis of the mobile mode

Parameters of menu Rpe:

Base

```
>>Rpe

Radio parameters:
(T)X:4110000*100Hz  (R)X:4110000*100Hz  ... working frequency
Frequency off(s)et:NONE  :0
Power - (l)evel:7  mW:275
(c)heck period:0
(1)-tx  (2)-rx                    ... identification of other channels
de(f)ault (r)ead (w)rite              at a common location
(I)nit (S)ync
(q)uit
>>1

Allowed TX freqs: (*100Hz)
(0) :111  (8) :0      ... non-zero value identifies active CU (0),(1) at
(1) :111  (9) :0          location, whose addresses are specified in table
(2) :0  (A) :0
(3) :0  (B) :0
(4) :111  (C) :0      ... active channel (4)
(5) :0  (D) :0
(6) :0  (E) :0
(7) :0  (F) :0
(q)uit
>>q
>>2
Allowed RX freqs: (*100Hz)
(0) :111  (8) :0
(1) :111  (9) :0
(2) :0  (A) :0
(3) :0  (B) :0
(4) :111  (C) :0
(5) :0  (D) :0
(6) :0  (E) :0
(7) :0  (F) :0
(q)uit
>>
```

Mobile station

```
>>Rpe

Radio parameters:
(T)X:4110250*100Hz  (R)X:4110250*100Hz  ... current working frequency,
Frequency off(s)et:NONE  :0                changes according to selected
Power - (l)evel:7  mW:380                  Base, not configured
(c)heck period:30
(1)-tx  (2)-rx                         ... identification of other
de(f)ault (r)ead (w)rite                   possible channels
(I)nit (S)ync
(q)uit
>>1

Allowed TX freqs: (*100Hz)
(0) :4110000  (8) :0            ... frequencies of available channels,
(1) :4110250  (9) :0                transmitting TX
(2) :0   (A) :0
(3) :0   (B) :0
(4) :4111000  (C) :0
(5) :0   (D) :0
(6) :0   (E) :0
(7) :0   (F) :0
(q)uit
>>q
>>2
Allowed RX freqs: (*100Hz)
(0) :4110000  (8) :0            ... frequencies of available channels,
(1) :4110250  (9) :0                receiving RX,
(2) :0   (A) :0                     in simplex CUs RX is the same as TX
(3) :0   (B) :0                     in duplex CUs they are different
(4) :4111000  (C) :0
(5) :0   (D) :0
(6) :0   (E) :0
(7) :0   (F) :0
(q)uit
>>
```

Parameters of menu DGe for mobile mode:

```
>>DGe

Dynamic routing: Globals
m(o)de:MM ROUTER         ... selection Router/Base/Mobile
validity (t)imeout:120sec  ... validity of entry in dynamic table
(N)id:1                  ... selection of node for this mode
Parameters:
mm (m)obile              ... other parameters for Mobile station
mm mob(i)le obsol        ... older Mobile mode, in menu FPe formerly
mm ro(u)ter              ... other parameters for Router
mm (b)ase                ... other parameters for Base
```

```
ob(s)olete
de(f)ault (r)ead (w)rite
(I)nit (S)ync
(q)uit
>>
```

Router

```
>>DGe u

Router mode parameters:
Mobile: (b)ase:690F8000  (m)ask:FFFF8000  (c)entre:690F7E05
Load treshold: Lo(w)/M-L:200promile  Hi(g)h/H-M:600promile
Load meas (T)au:5000ms  (o)wn load treshold:500bps
debug via (S)ystem channel:OFF
(q)uit
>>
```

(b)   (b)ase:690F8000 - reference address for definition of Mobile stations

(m)   (m)ask:FFFF8000 - mask for definition of Mobile stations

(c)   (c)entre:690F7E05 - address of central application

(w)   Lo(w)/M-L:200promile - evaluation of RF load, less than 20% is level 3

(g)   Hi(g)h/H-M:600promile - 20% to 60% is level 2, more than 60% is level 1

(T)   (T)au:5000ms - auxiliary parameter for evaluating RF load

(o)   (o)wn load threshold:500bps - auxiliary parameter for evaluating data load

(S)   (S)ystem channel:OFF - switches on transmission of debug messages to the System channel
       `ise 1`

Bases

```
>>DGe b

Base mode parameters:
Mobile: (b)ase:690F8000  (m)ask:FFFF8000  (c)entre:690F7E05
Base info (t)imeout:30sec  base-centre (e)cho timeout:0sec
Load treshold: Lo(w)/M-L:200promile  Hi(g)h/H-M:600promile
Load meas (T)au:5000ms  (o)wn load treshold:500bps
(D)isable:OFF
debug via (S)ystem channel:OFF
(q)uit
>>
```

In addition bases use the following parameters:

(t)   Base info (t)imeout:30sec - interval for sending packet `base info` to the RF channel

---

(e)   base-centre (e)cho timeout:0sec - interval for sending ETH test pings to the centre - if no response returns transmission on the RFC is interrupted, the dialog with other Bases is disabled and the Mobile station then switches to another Base

(D)   (D)isable:OFF — normal state

        (D)isable:ON — Base is disabled, the dialog with other Bases on the location is disabled and the RFC transmission is interrupted

Mobile station

```
>>DGe m

Mobile mode parameters:
Apps:  (b)ase:690F7E00  (m)ask:FFFFFE00  (c)entre:690F7E05
Base:  (B)ase:690F0000  (M)mask:FFFF8000
(P)assive:OFF  (h)ome frequency id:1
(r)etune timeout:30sec  (k)eep timeout:30sec
(p)ifka timeout:60sec
Load treshold: Lo(w)/M-L:200promile  Hi(g)h/H-M:600promile
Load meas (T)au:5000ms  (o)wn load treshold:500bps
debug via Event (L)og:OFF
debug via (S)ystem channel:OFF
Retune method parame(t)ers
(q)uit
>>
```

(b)   Apps: (b)ase:690F7E00 - reference address for definition of applications

(m)   Apps: (m)ask:FFFFFE00 - mask for definition of applications - packets sent to these addresses renew records in dynamic tables of Bases and Routers and prevent the transmission of a keep packet for the period DGemk

(c)   (c)entre:690F7E05 - address of central application - keep packets leave to this address

(B)   Base: (B)ase:690F0000 - reference address for definition of Bases

(M)   Base: (M)mask:FFFF8000 - mask for definition of Bases - only these addresses are accepted as a Base

(P)   (P)assive:OFF - standard state - with this setting station MR switches the antenna through the duplexer to MR or MW during a change of operation between the narrow and wide band. The signal is on SCC3 pin CD. Others pins on SCC3 works standardly and they can transfer the data of the protocol configured.

        (P)assive: ON - MR does not give a signal for the duplexer

(h)   (h)ome frequency id:1 - number of the channel on which the Mobile station begins to search for a Base upon start up or upon a loss of connection

(r)   (r)etune timeout:30sec - the Mobile station does not switch between various frequencies before this time has elapsed; when switching between Bases from various locations on the same frequency this limitation does not apply (so-called rapid switch)

(k)   (k)eep timeout:30sec - in this interval the Mobile station sends a maintenance packet to the Centre to address DGemc

(p)   (p)ifka timeout:60sec - the parameter Crit is reduced for this time period for the Base with which problems occur in communication - this results in switching to another Base, if available

(w)   Lo(w)/M-L:200promile - limit for distinguishing the load levels 3 and 2 on the RF channel - for a load on the RFC for less than 20% of the time the level is 3

(g)   Hi(g)h/H-M:600promile - limit between level 2 and 1 - a load greater than 60% gives level 1

(T)   Load meas (T)au:5000ms - auxiliary parameter for evaluating RFC load

(o)   (o)wn load threshold:500bps - auxiliary parameter for evaluating data transfer load

(L)   debug via Event (L)og:OFF - record to debug messages to Event log

```
(0) OFF         ... off
(1) PROBLEMS    ... erroneous configuration of frequencies,
                        loss of location
(2) +RETUNE INFO ... (1)+ retuning to another Base
(3) FULL DIAG   ... all messages
```

(S)   debug via (S)ystem channel:OFF - messages sent to System channel 1 (menu ise)

```
(0) OFF   ...off
(1) INFO  ...message about switching Bases, etc
(2) TRACE ...message sent with an interval of 1 sec
(3) FULL  ...table mrm sent with in interval of 1 sec,
                heavy channel loading
```

(t)   Retune method parame(t)ers - parameters which are important for retuning to another Base:

```
>>DGE mt

Retune method parameters:
Retune m(o)de:RSS/DQ
(D)q weigh [mode RSS/DQ]:700promile
(M)edia type setting
Criterium (h)ysteresis:20promile
Dq  transform curve: Kx(1):15  Ky(2):950promile
Rss transform curve: Kx(3):85dBm  Ky(4):800promile
Problem meas (T)au:15000ms  (P)roblem treshold:900promile
Problem (u)ncertainity treshold:100 [1/100]
Bobeks:
(r)ss:150promile  (p)ifka:250promile
(c)onnection:250promile
pac(k)ets:650promile
(q)uit
>>
```

(o)   Retune m(o)de:RSS/DQ - method of processing RSS and DQ when evaluating a Base

```
(0) RSS/DQ ...DQ has a weight according to DGemtD,
             the weight of RSS is an increment to 1000
(1) DQ     ...other weights, under development
```

(D)   (D)q weigh [mode RSS/DQ]:700promile - weight DQ, weight RSS is 1000 - D

       For all Bases at one location there is taken a common value of RSS and a common value of DQ.

(M)   (M)edia type setting - transmission media in individual channels are characterised by a four-bite character, for example:

```
MR:  0010 = 0x02
MW:  0101 = 0x05

meaning of bits from the left:
bit  3   - res
bit  2   - 0 channel preferred for transfer of individual packets
               (packet)
             1 channel preferred for transfer of a large amount
               of data (connection)
bity 1,0 - 00 ETH
             01 wide - wideband
             10 narrow - 25 kHz band
             11 microwave channel
```

(h)   Criterium (h)ysteresis:20promile - parameter Crit must change by at least this value in order to induce a change in channel

(1)   Dq transform curve: Kx(1):15 - for converting DQ values into a value used in the calculation a pair of abscissae defined by coordinates DQ/value are used: 0/0, Kx(1)/Ky(2), 31/1000.

(2)   Dq transform curve: Ky(2):950promile - second coordinate of conversion abscissae for DQ

(3)   Rss transform curve: Kx(3):85dBm - definition of conversion abscissae for RSS

(4)   Rss transform curve: Ky(4):800promile - second coordinate of conversion abscissae for RSS

(T)   Problem meas (T)au:15000ms - auxiliary parameter for the calculation of parameter Problem, a longer time increases the influence of historic values of the parameter Problem and slows down the reaction to new events

(P)   (P)roblem treshold:900promile - parameter Problem is calculated from more indicators, it rises particularly during unsuccessful communication with the centre. If the limit (P)roblem treshold is exceeded then Pifka status is set for this channel. This results in the Mobile station attempting to use a more suitable Base.

(u)   Problem (u)ncertainty treshold:100 [1/100] - together with parameter Problem the parameter Problem uncertainty is also calculated. Uncertainty drops with fresh data about successful or unsuccessful communication. Uncertainty cannot be greater than the limit set here in order to allow for the application of Pifka.

(r)   (r)ss:150promile - all criteria at the location are multiplied by this value (=0.15) with the exception of channel home (DGemh) in the case where RSS weakens to below -95dBm. This results in switching to channel home on which setting up communication to the next location is easier.

(p)   (p)ifka:250promile - the criterion of the channel to which status pifka was applied is multiplied by this value (=0.25). This results in the Mobile station switching to another Base if available.

(c)   (c)onnection:250promile - during the transfer of "connection" type data, i.e. a large volume of data, the criterion on channels unsuitable for this transfer is multiplied by this value (=0.25). An example of this are channels with parameter DGemtM0 = 2, i.e MR160.

(k)   pac(k)ets:650promile - during the transfer of "packet" type data, i.e. short packets, the criterion on channels unsuitable for this transfer is multiplied by this value (=0.65). An example of this are channels with parameter DGemtM0 = 5, i.e. MW160.

The result of the last two parameters is that narrowband (MR) modems deal with the transfer of short data and wideband modems (MW) remain available for the transfer of large volumes of data. These transfers to various Mobile stations can occur simultaneously.

Diagnostic report at Router

```
690F00FEh>mrd
690F00FEh>Drt: 1 120
d690F8001 t690F0101 q23 120
690F00FEh>
```

A dynamic routing table for each recorded Mobile station contains address `to`, via which the Mobile station is accessible.

- Drt: 1 120 - Dynamic routing table, number of recorded Mobile stations, max. timeout

- d690F8001 t690F0101 q23 120 - address `destination` (in Mobile station), address `to` (in Base), remaining validity time (120) is set to a maximum with each packet, i.e. also with this query

Diagnostic report at Base

Dynamic routing table:

```
690F0100h>mrd
690F0100h>Drt: 3 120
d690F8001 t690F8001 q85 120
d690F8000 t690F8000 q67 0
d690F8003 t690F8003 q72 0
690F0100h>
```

The content of the table has the same meaning as in the case of the Router. Several Mobile stations are recorded here whose timeout has already elapsed.

Overview of Bases at a common location:

```
690F0100h>mrb
690F0100h>Bt: 3 120 dis:0
addr:690F0110 bir:0433 ttl:0.000000
addr:690F0104 bir:0133 ttl:120.000000
```

```
addr:690F0100 bir:0033 ttl:118.000000
690F0100h>
```

- Bt: 3 120 dis:0 - Base table, number of Bases at a location, max. timeout, ban on RF operation as a result of a loss in connection with the centre, see menu DGebe (0 - RF operation permitted)

- addr:690F0100 bir:0033 ttl:118.000000 - address of Base, its channel number (00), RF channel load (33), remaining validity time

Diagnostic report at Mobile station

```
>>mrm
>>Mt: 2 120 TLeft:expired B:690F0100 Dis:0 Rss:-74 Crit:992 DQ:31 FID:0
KLeft:7 Clu:0 Wm:Loc:0.00 Rmt:0.00 Load:rx:0.03;415.3bps tx:0.02;275.63bps
Problem: y:0.376 dy:0.725 TAdren:0

Addr:690F0100 Rss:-74 Dq:31 ttl:115
 33| 22! 00  00  00  00  00  00  00  00  00  00  00  00  00  00
992|892!  .   .   .   .   .   .   .   .   .   .   .   .   .   .
  .|  .!  .   .   .   .   .   .   .   .   .   .   .   .   .   .
Addr:690F0200 Rss:-87 Dq:30 ttl:5
 00  23! 00  00  00  00  00  00  00  00  00  00  00  00  00  00
  . 928!  .   .   .   .   .   .   .   .   .   .   .   .   .   .
  .   .!  .   .   .   .   .   .   .   .   .   .   .   .   .   .
0. Addr:00000000 n:0
1. Addr:00000000 n:0
2. Addr:00000000 n:0
>>
```

- Mt: 2 120 - Mobile table, number of captured locations (2) and the validity time of the record (120s)

- TLeft:expired - time (sec) remaining until the end of the ban on retuning to another frequency, decrements from the original value in menu DGe (r)etune timeout:30sec achieved upon a change in frequency. The idle value has expired.

- B:690F0100 - address of active Base

- Dis:0 - disabled - 0 is an active member of a MR-MW pair, 1 is a passive member

- Rss:-74 - Rss Base selected by a Mobile station

- Crit:992 - Criterion of the selected Base, Criterion is a calculated number which includes all envisaged circumstances for the selection of the optimum Base

- DQ:31 - DQ of selected Base

- FID:0 - number of selected frequency channel

- KLeft:7 - number of seconds remaining until the keep packet is sent to the centre

- Clu:0 - operation in a cluster, 0 means that only MR stations are at the location, 1 denotes operation of MR and MW at the location

- Wm:Loc:0.00 Rmt:0.00 - watermark - load on communication line, original information for switching to MR or MW channel

- Load:rx:0.03;415.30bps tx:0.02;275.63bps - actual data flow on the line

- Problem: y:0.376 dy:0.725 - calculated number including the influence of the connection which couldn't be made. If Problem exceeds the level of DGemtP, the channel is assigned Pifka status.

- TAdren:0 - number of sec remaining until the end of a hard switch over to MR or MW operation, see menu mA

The following four rows for each location from which the message base info is captured:

- `Addr:690F0100 Rss:-65 Dq:22 ttl:104` - address which applies to node 1 and channel f0 at a given location. Other addresses at a location are derived by adding 4 for each additional channel. Rss and DQ are ascertained from a received packet base info and this value is used for other channels at the location. Time ttl:104 remains until the end of the validity of the record. It is set to a value DGet after the receipt of each packet from a Base.

- `33| 22! 00 00` - RF channel loading of individual Bases. Value 33 is low loading, 22 medium, 11 high, 00 means there is no information about the Base. Load limits are set using parameters DGebw, DGebg in Bases. A vertical line denotes a Base which is working, and an exclamation mark denotes the home frequency.

- `992|892!  .  .  ` - Criterion calculated for an individual Base. A Mobile station selects the Base with the highest Criterion. This parameter is calculated with respect to a number of factors. Here the criterion is reduced for channel f1 as a result of the influence of greater RF channel loading of this channel.

- `.|  .!  .  .  ` - the time (sec) remaining until the end of the validity of the Pifka status is entered into this row. At the beginning of the Pifka status the time here is according to DGemp, and the time is according to menu mP in the case of manually inducing this status.

The last three rows at the end of the message acts as a filter for newly captured Bases:

- 0. Addr:00000000 n:0 - each Base that is captured for the first time is recorded here. Only after the second packet is received from this Base is it classed as an active Base. The entry is then not taken into consideration. A max. of 3 new Bases can be recorded at once.

Diagnostic message at Mobile station - general

```
>>mg
>>Mt overview:
 TLeft:exp. B:690F0100 Dis:0 Rss:-70 DQ:30 FID:0
690F0100:XN++N++++++++++
690F0200:,^,,,,,,,,,,,,,
>>
```

Brief version of the message mrm. Suitable for work in heavily loaded networks.

Diagnostic message at Mobile station - abbreviated

First in menu `ma` insert the address of the location, i.e. the address respective to channel f0, node 1. Then upon request `mG` we obtain a statement from message `mrm` restricted to the selected location.

```
>>mG
>>Mt location: 690F0100 TLeft:expired B:690F0100 Dis:0 Rss:-70 Crit:988
DQ:30 FID:0 KLeft:10 Clu:0 Wm:Loc:0.00 Rmt:0.00 Load:rx:0.00;0.00bps
tx:0.00;3.96bps Problem: y:0.000 dy:1.505 TAdren:0

Addr:690F0100 Rss:-70 Dq:30 ttl:106
 33! 33| 00  00  33| 00  00  00  00  00  00  00  00  00  00  00
988!988|  .   . 988|  .   .   .   .   .   .   .   .   .   .   .
 .! .| .   .   .|  .   .   .   .   .   .   .   .   .   .   .
>>
```

Test Base Info

Using command ` mB ` sent to the Base we cause the message ` Base info ` to be sent via the RF channel of this Base. Regular transmission of ` Base info ` runs at intervals ` DGebt `.

3. Dynamic routing - Next Hop

The Next Hop function is used for switching to an alternative route if there is a failure of any of the CUs on the transfer route. The node in Next Hop mode works with the main set of routing tables. It also a set of back-up tables available for use if the connection to the nearest adjacent node according to the main set is lost.

An example of a back-up connection between nodes 01 and 04:

```
                     02
                 .       .
              .              .
           .                    .
       ---- 01                  04 ----
     Tl1: 04>02   .            .   Tl1: 01>02     main table
     Tl2: 04>03      .      .      Tl2: 01>03   back-up table
                  .       .
                     03
```
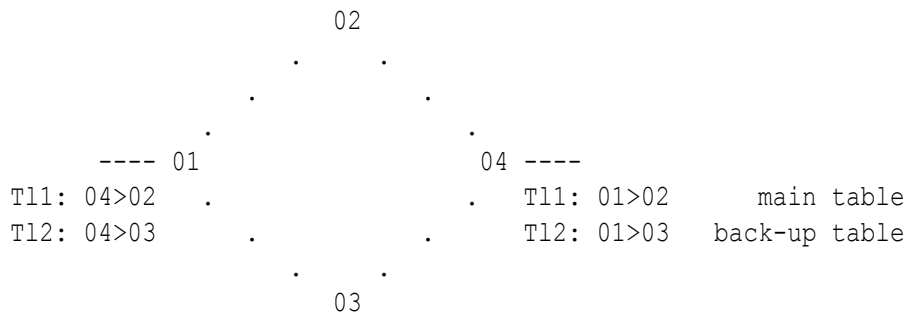
Settings in menu **Ne**:

```
Nid|address |M | u    s | L    N |l w n g H|sTO Err   Cent vTO hTO
(0) 0049C067      -  S00| -  R00|0 0 0 0 -| 15 SERV  OFF 304  30
(1) 690F0001    S00 S00| -  R01|1 0 0 0 -| 15 SERV  OFF 304  30
(2) 00000000    S01 S00| -  R02|0 0 0 0 -| 15 SERV  OFF 304  30
 ....
```

Definition of back-up tables in menu **DNe**:

```
  Node Extensions:
     retab
Nid |l w n g| Mode
(0) |0 0 0 0| 0
(1) |2 0 0 0| 1              ...back-up set of tables for node 1
(2) |0 0 0 0| 0
 ....

>>1

Node Extensions:
(l)o:2 (w)i:0 (n)e:0 (g)l:0 (H)rt:0
(K)eep lines:ON          ...activation of transmission of keep packets
```

Switching on Next Hop mode in menu **DGe**:

```
Dynamic routing: Globals
m(o)de:NEXT HOP          ...Next Hop mode
validity (t)imeout:120sec ...interval of transmission of keep packets
(N)id:1                  ...applies to node number 1
Parameters:
 ....
```

The node in Next Hop mode sends keep packets to the nearest nodes based on the main and back-up routing tables.

```
12:39:26.032|690F0002 690F0001|690F0002 690F0001|7AB  RFTX    0 90 0dat 0
12:39:26.073|690F0001 690F0002|                   |7AB*31~ 70  0*06  ack
12:39:33.038|690F0003 690F0001|690F0003 690F0001|7AC  RFTX    0 90 0dat 0
12:39:33.078|690F0001 690F0003|                   |7AC*31~ 70  0*06  ack
```

Based on ACK the dynamic table is updated. This is available for diagnostics purposes through command **mrt**:

```
>>mrt

>>Tt: 2 120
Tt:nid:1 toa:690F0002 ttl:12.000000 m:2.000000
Tt:nid:1 toa:690F0003 ttl:29.000000 m:2.000000
```

Items in the table:

```
Tt:nid:1          number of node in Next Hop mode
toa:690F0002      address of tested adjacent node
ttl:12.000000     remaining validity time(12sec)
m:2.000000        line status:
   2  line OK
   1  one packet wasn't ACK acknowledged on the routing channel
   0  two or more packets didn't receive ACK,
      switch to back-up set of tables
  -1  unknown line status
```

The table can be generated automatically every second and sent to the monitoring system channel number 1 (menu **ise1**). Generation is switched on using command **DGeuSn**. Be careful not to overload the RFC during transmission of monitoring via the radio.

The line status is evaluated according to ACK on the routing channel. If this channel is Ethernet with ACK switched off and thus no ACK arrives use mode NEXT HOP+KEEPS. In menu **DGe** select:

```
Dynamic routing: Globals
m(o)de:NEXT HOP+KEEPS    ...mode Next Hop+Keeps
validity (t)imeout:120sec
(N)id:1
```

Now the keep packets looks as follows:

```
13:28:38.034|690F0002 690F0001|690F0002 690F0001|0EE  RFTX    2 94 5dat 0
0001
13:28:38.074|690F0001 690F0002|                   |0EE*30~ 71  0*06  ack
13:28:38.113|690F0001 690F0002|690F0001 690F0002|1A7*29* 71  2*94 5dat 0
8001
13:28:38.113|690F0002 690F0001|                   |1A7  RFTX    0 06  ack
```

A response (with data 8001) is sent to each keep packet (with data 0001) from the opposite node. Based on this response the line status is determined, even in the case where no ACK arrives.

Nodes in Next Hop mode can be chained further. In the following example data is transferred between nodes 01 and 06. If any of the nodes 02,03,04,05 fail they are automatically replaced by the back-up line.

```
          Tl1: 06>04      Tl1: 01>02      main table
          Tl2: 06>05      Tl2: 01>03   back-up table


               02 . . . . . . 04
 Tl1: 04>02     .  .        .  .        Tl1: 01>04
     05>02    .      .     .      .          02>04
     06>02  .          . .           .       03>04
   ------ 01              .           06 ------
 Tl2: 04>03  .          . .          .  Tl1: 01>05
     05>03    .      .     .      .          02>05
     06>03     .  .        .  .              03>05
               03 . . . . . 05


          Tl1: 06>04      Tl1: 01>02      main table
          Tl2: 06>05      Tl2: 01>03   back-up table
```
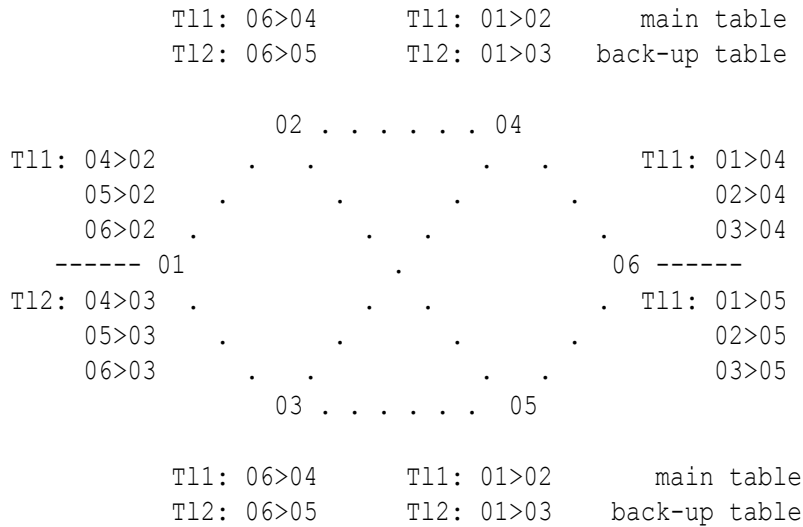
Rules for network creation in the example:

```
                02
              .     .
            .         .
      ---- 01           04 ----
            .         .
              .     .
                03
```
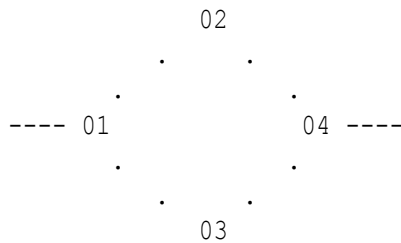
- node 01 chooses between the main (02) and back-up (03) route.

- test of connection and selection only concerns the next step (next hop).

- selection of main/back-up route takes place according to ACK response to prior keep or data packet.

- the route in the other direction must be assessed and switched by another node, which has the chance to select between two routes. Here it is node 04, and nodes 04,05,06 in the previous more complicated example.

- a fault on the route must be detected from both sides so that both directions are switched to the back-up route. Here, upon switching off CU 02 a failure is registered by nodes 01 and 04 and both switch to the back-up direction via 03.

- it is not a good idea to combine different media, for example, during a connection between CU 01 and CU 02 over a wire link a fault on CU 02 will be correctly identified only when switching off the whole of station 02. If only one of the channels is interrupted (SCC or RFC), then the fault from the other side will not be ascertained and the back-up line will only be switched in one direction. In the other direction the connection will remain interrupted.

- similarly it is not a good idea to line several CUs behind each other without branching:

```
            02 . . 04
           .          .
          .            .
   ---- 01                06 ----
          .            .
           .          .
            03 . . 05
```
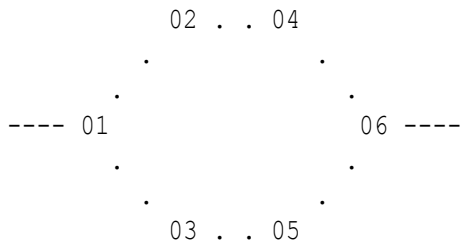
If there is a failure of any of the stations 02,03,04,05 the route is switched by only one of the end stations 01 or 06 and two-way transmission is lost.

- on switching to a back-up set of routing tables the whole set g,n,w,l is switched. It is necessary to fill in all tables, even in the back-up set, if they are used in routing.

- switching to a back-up route occurs after assessing the loss of two packets. These are not delivered to the end station.

4. Tunnel Morse-Morse

Tunnel MORSE-MORSE (TMM) is configured using the "Network Agent" (NAG) channel. This channel behaves in a similar way to the SCC from the point of view of configuration, however, it doesn't have a physical output. After entering the NAG the packet is suitably modified and then sent via one of its "retranslation" or "user+service" outputs to a node within its CU.

Function of the Network Agent:

If a packet arrives to NAG from a node from the network output N it is fully packed into a service packet and given a new address.

- Address dst is derived from the original dst address. Where there are "1" bits in the "GPe0ptm" mask the original dst address is maintained. In those bits where the mask is zero its bits are replaced with the respective values from the parameter addr. "GPe0pta".

- Address src is taken from the node which the "service" output NAG is connected to.

- A packet set up in such a way is a "service" type packet, i.e. 12 or 92.

- Service output NAG is connected to a suitable node, from which this packet then travels through the MORSE network to the dst address.

The following example was monitored in the CU according to the diagram shown on the left below:

```
Monitoring: source 690F8000|3.
CNI mon     |toa       frm     |dst       src     |        size|TT N
16:05:15.618|690F2001 690F8002|690F2001 690A0100|G00I    IN    2N09 1dat
AAAA
16:05:15.619|                 |690F1001 690F8000|G00I   OUT   12| 92 5serv
0129 690F 2001 690A 0100 AAAA
```

In the target node the packet is separated from the other "user" packets and continues via the "service" output to NAG. Here the original routing packet is unpacked from the service packet and is sent from the NAG output "ret" to a suitable node. From here it continues through the MORSE network in the standard manner.

The example was monitored in the CU according to the diagram on the right:

```
16:05:12.850|                 |690F1001 690F8000|G00I    IN   12|_92 5serv
0129 690F 2001 690A 0100 AAAA
16:05:12.850|690F1001 690F8000|690F2001 690A0100|G00I   OUT    2n09 1dat
AAAA
```

```
        _____                        _____
  ____   TMM->|      |              |      |
 | un |-r-----| Center |-N-RFC        | Mobile |-N-RFC
 |    |       |690F8000|              |690F1001|
 |pack|-s-----|        |         ____  |pack|-s-----|        |              ___
 |____|       |_____|-s-setr  | un |    |    |        |_____|-s-----| un |
   |          |        |         |____|    | un |-r-----|        |        |    |
   |          |        |-N-----|pack|      |____| TMM->|        |-N-----|pack|
   |          |690F8002|  ->TMM|    |        |          |690F2001|  ->TMM|____|
   |          |        |       |    |        |          |        |        |
   |          |_____|-s-----| un |        |          |_____|-s-setr  |
   |          |        |       |____|        |          |        |         |
   |          |        |         |           |          |        |         |
   |          |        |         |           |          |        |         |
   +------------<<-------------+             +--<---------------------<--+
                       a:00001000                               a:690F8002
                       m:FFFF0FFF                               m:00000000
```
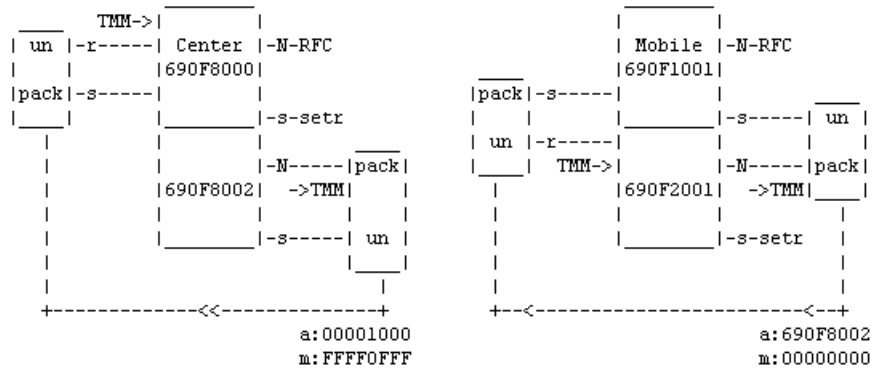
Example of the composition of the NAG packet: `0129 690F 2001 690A 0100 AAAA`

0129   header

690F 2001   dst address of original packet

690A 0100   src address of original packet

AAAA   data of original packet

NAG Parameters:

From the Main menu using command **GPe**:

```
Nag:
 id |typ|subt|  addr |  mask  |
(0) 0001 0000 00001000 FFFF0FFF
(1) 0000 0000 00000000 00000000

de(f)ault (r)ead (w)rite
(I)nit (S)ync
(q)uit
>>
```

Select either of the two NAG and insert type TMM:

```
Ott
```

Return to the menu `GPe` and insert parameters:

```
Opt
```

```
Tunnel Morse-Morse parameters:
(s)ubt:0000
(a)ddr:00001000
(m)ask:FFFF0FFF
(q)uit
>>
```

Meaning of parameters:

(m)ask   denotes which parts of the dst address will be taken to service packet address

(a)ddr   determines what left out parts will be replaced with

(s)ubt   reserve field

4.1. TMM in the Mobile network

The mobile network is capable of transferring packets between the Center and Mobile. The route, however, cannot be extended using standard routing procedures on either the Center side or Mobile side. In these cases we have to make use of the Network Agent and configure the Tunnel Morse-Morse through the mobile network. The configuration example follows on from the previous example of the mobile connection and is supplemented with the TMM configuration.

Passage of a packet from the supervisory center `690A0100` through tunnel TMM to node `690F4001` in the Mobile and back:

```
u S02   690A0100    R01
31/ 68  690F8000    -
   -    690F8002    G00
 G00    690F2001    -
   -    690F4001   serd

 serd   690F4001    -
   -    690F2001    G00
 G00    690F8000    R01
30/ 75  690A0100  u S02
690F4001h>
```

The packet passes through the section from `690A0100` to `690F8002` through the use of routing tables. Here it enters the tunnel, through which it is transferred as the service packet over the mobile section. This part of the route is not displayed in listing; it behaves as an inserted block. It then continues again from `690F2001` to `690F4001` according to the routing tables.

```
                                  _____
                              .|  Base  |-N-RFC.
                          .    |690FC000|      .
                     .         |    1   |          .
                .              |_____|              ._____
         ____      TMM->|        |.      Twl:80to8000     |        |
        |  un |-r-----| Center |-N-RFC                  | Mobile |-N-RFC
        |     |       |690F8000|                        |690F1001|
        |pack|-s-----|   1  1  |           ____         |pack|-s-----|        |
        |____|      .|_____|-s-setr     |    |       |     |       |_____|-s-----|  un |
           |      .  |          |          | un |-r-----|     |       |        |       |     |
           |      .  |          |-N-----|pack|       |____|   TMM->|        |-N-----|pack|
           |      .  |690F8002|  ->TMM|    |          |        |690F2001|        ->TMM|____|
           |.    rTab:|   2    |       |   |          |        |rTab:2  |              |
           .|        |_____|-s-----| un |          |        |_____|-s-setr       |
          . |                 |____|    |             |        |        |              |
          . |                         |               |        |        |              |
          .  +-------------<<--------------+       +--<         |        |      <--+
          .   Twl:10to8002        a:00001000       |           |        | a:690F8002
          .      20   8002        m:FFFF0FFF        |           |_____| m:00000000
          .      40   8002                          |           |        |
          .      CO   C000                          |           |        |
          .      C1   C100                          |690F4001|
          .   Tnl:0Ato690A0100                      |   4  4  |
          . Tn2:0A  690F8000                        |_____|
             .  _____                           Tw2:10to1001
             |        |-N-RFC                          40   4001
             |690A0100|                            Tw4:20   2001
        rTab:|   1    |                                 80   2001
             |_____|-s-setr                     Tn4:0Ato690F2001
          Tnl:0Fto690F8000
```

Notes on configuration:

- An auxiliary node whose network output is directed towards NAG is added in the Center and in the Mobile. This node is the beginning of the tunnel.

- The node at the beginning of the tunnel does not have routing tables for the direction "to the tunnel" which is why its sends all packets to its output "N" and thus to NAG. A routing packet which arrives at the tunnel in this way is packed in NAG (marked as "pack"). The packed packet then leaves NAG as a service packet and the output is again marked as "pack".

- The mask and address in menu `GPeOpt` are inserted in such a way that NAG creates a dst address directed at a node with output "s" connected to the opposite NAG.

- In the Center the 4th character of the address from the right is replaced with `1`, and the others remain the same. The three lower characters of the address determine the Mobile; the 4th character distinguishes the other nodes connected to this mobile. As an example, the following addresses are used in the Mobiles:

Mobile 1	Mobile 2	Mobile 3	Mobile 4
690F1001	690F1002	690F1003	690F1004
690F2001	690F2002	690F2003	690F2004
690F4001	690F4002	690F4003	690F4004

- The complete address 690F8002, at which tunnels of all Mobiles end, is inserted into the dst address in the Mobile.

- Nodes at which the tunnel ends are supplied with routing tables for distribution of routing packets which arrived from the tunnel. For node `690F2001` this is Tw2 and for node `690F8002` it is Tn2.

- Other routing tables serve for sending packets to the beginning of the tunnel. For node `690F4001` they are Tw4 and Tn4, for node 690F8000 fields 10,20,40 in Tw1.
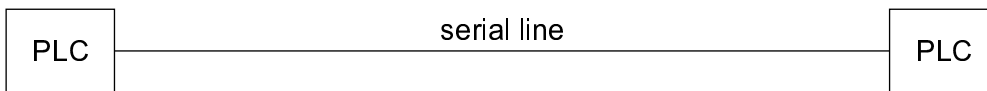
5. Telephone transmission in MORSE

There are several examples of a telephone network appearing in the MORSE system:

5.1. Connection of two PLCs over the MORSE network

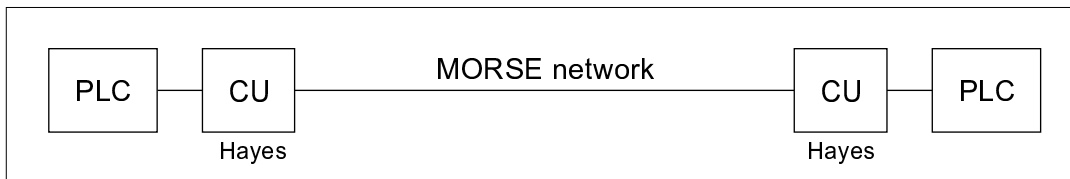It is used with the Hayes protocol as an alternative to telephone modems and a telephone network.

Direct connection of two PLCs

```
PLC ────────── serial line ────────── PLC
```

Connection over a telephone network and TM telephone modems

```
PLC ── TM ────── telephone network ────── TM ── PLC
```
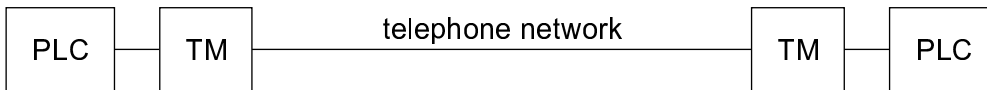
Connection over the MORSE network

```
PLC ── CU ────── MORSE network ────── CU ── PLC
       Hayes                          Hayes
```
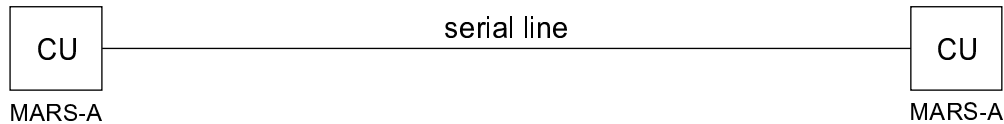
The block **CU-MORSE network-CU** behaves in the same way as block **TM-telephone network-TM** and replaces the link between both PLCs. Data is transmitted through the MORSE network in packets as opposed to connection-oriented transmission over the telephone network. For a more detailed description see Hayes protocol for MORSE[1].

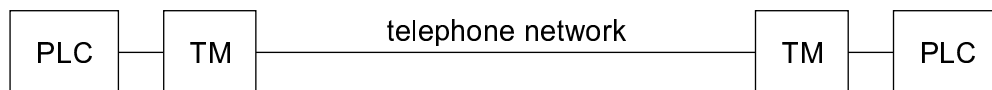[1] https://www.racom.eu/eng/support/prot/hayes/index.html

5.2. Connection between two CUs over a telephone network

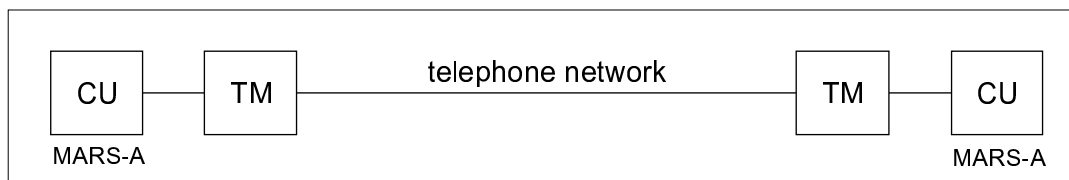This is used in the case of servicing a CU which is out of reach of a MORSE network.

Direct connection of two CUs

```
┌──────┐                serial line               ┌──────┐
│  CU  │────────────────────────────────────────│  CU  │
└──────┘                                          └──────┘
MARS-A                                            MARS-A
```

Connection over a telephone network and TM telephone modems

```
┌──────┐ ┌──────┐      telephone network      ┌──────┐ ┌──────┐
│ PLC  │─│  TM  │────────────────────────────│  TM  │─│ PLC  │
└──────┘ └──────┘                             └──────┘ └──────┘
```

Service connection of two CUs over a telephone network

```
┌──────────────────────────────────────────────────────────┐
│ ┌──────┐ ┌──────┐    telephone network    ┌──────┐ ┌──────┐ │
│ │  CU  │─│  TM  │────────────────────────│  TM  │─│  CU  │ │
│ └──────┘ └──────┘                         └──────┘ └──────┘ │
│ MARS-A                                           MARS-A     │
└──────────────────────────────────────────────────────────┘
```

CUs with MARS-A protocols can communicate this way through telephone modems via a telephone network. This is used occasionally for servicing. The use of a telephone line is not suitable for normal data transmission. For a more detailed description see the MARS-A protocol[2] description, chapter Connection via telephone or GSM modem.

5.3. Data transmission over a GPRS network

```
┌──────────────────────────────────────────────────────────┐
│ ┌────────┐           data transfer          ┌────────┐    │
│ │ MG100  │─────────────────────────────────│ MG100  │    │
│ └────────┘           in GSM network          └────────┘    │
│   PPP                                           PPP        │
└──────────────────────────────────────────────────────────┘
```
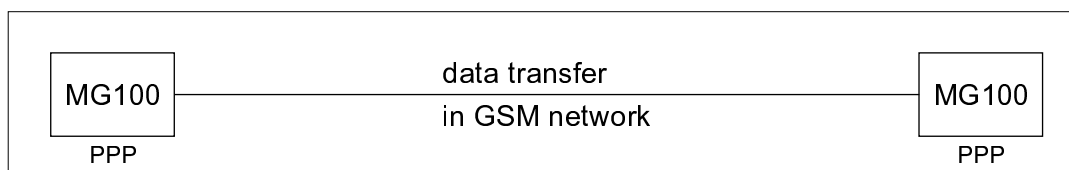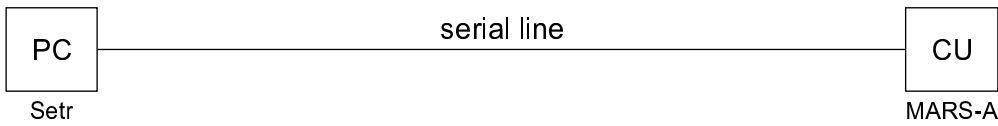
MG100 is a MORSE communication unit which uses a GPRS module in place of a standard radio part. It transmits data over a GSM mobile telephone network. For a more detailed description see GPRS modem MG100[3].
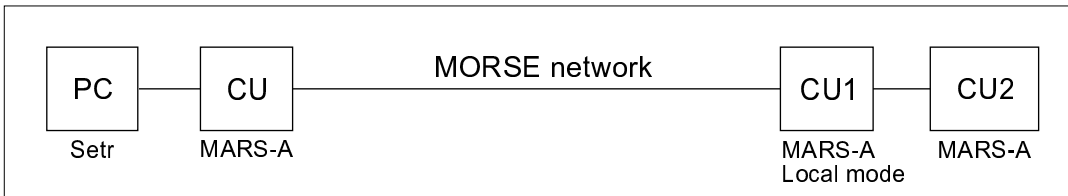
---

[2] https://www.racom.eu/eng/support/prot/mars-a/index.html
[3] https://www.racom.eu/eng/support/hw/mg100/index.html

5.4. Service cable - remote access

Connection between PC and CU via a service cable

```
┌──────┐                serial line                ┌──────┐
│  PC  │───────────────────────────────────────────│  CU  │
└──────┘                                            └──────┘
  Setr                                               MARS-A
```
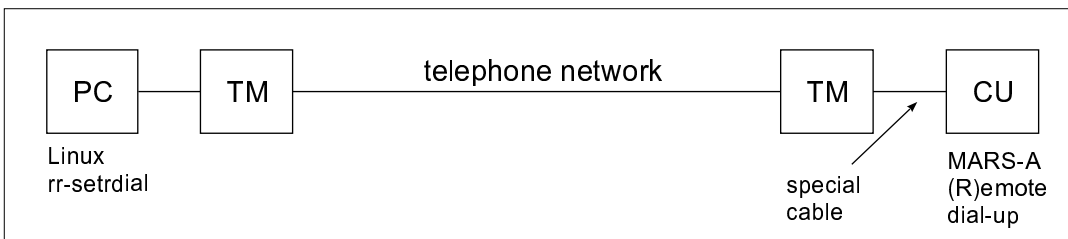
Standard connection between Setr and CU used for configuring the CU.

Connection between PC and remote CU over MORSE network

```
┌────────────────────────────────────────────────────────────────────────┐
│ ┌──────┐  ┌──────┐      MORSE network      ┌──────┐  ┌──────┐            │
│ │  PC  │──│  CU  │──────────────────────────│ CU1  │──│ CU2  │            │
│ └──────┘  └──────┘                          └──────┘  └──────┘            │
│   Setr     MARS-A                            MARS-A    MARS-A             │
│                                              Local mode                   │
└────────────────────────────────────────────────────────────────────────┘
```

This is used for service access to a remote, unconfigured CU2 via CU1, which is accessible via MORSE routing. A more detailed description is given in chapter Local mode in the MORSE guide.

Connection between PC and remote CU over a telephone network

```
┌────────────────────────────────────────────────────────────────────────┐
│ ┌──────┐  ┌──────┐    telephone network    ┌──────┐    ┌──────┐          │
│ │  PC  │──│  TM  │──────────────────────────│  TM  │ ↗  │  CU  │          │
│ └──────┘  └──────┘                          └──────┘    └──────┘          │
│   Linux                                        special    MARS-A         │
│   rr-setrdial                                  cable      (R)emote        │
│                                                           dial-up         │
└────────────────────────────────────────────────────────────────────────┘
```

This is used for service access to a remote, unconfigured CU using a telephone modem. The remote CU can have default settings, however, the only necessary parameter is (R)emote dial-up in the MARS-A protocol. For a more detailed description see the (R)emote dial-up access chapter in the MARS-A protocol[4] description.

---

[4] https://www.racom.eu/eng/support/prot/mars-a/index.html

6. Local Mode connection

The local mode is used for the connection from an accessible (local or remote) CU with address `xxxxxx0A` to another CU `xxxxxxxx`. These CUs are connected via the SCC and MARS-A protocol (or via the phone modem and MARS-A). This mode is useful in cases where the non-configured CU `xxxxxxxx` is out of reach, but it can be connected to the SCC on CU `xxxxxx0A` with the help of an assistant.
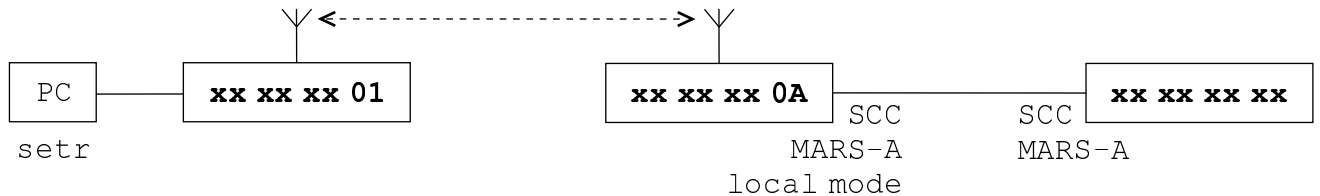

Fig. 6.1: Local mode in MARS-A protocol

These CUs `xxxxxx0A` and `xxxxxxxx` must be connected via the serial crossed cable (rx,tx,GND) between ports, where there is the MARS-A protocol.

When different protocols to MARS-A are set-up in `xxxxxxxx`, then it is possible to connect the port on `xxxxxx0A` via a crossed cable to the service cable and this to the service connector on `xxxxxxxx`. The MARS-A protocol then sets itself up automatically. The address `xxxxxxxx` can be arbitrary.

The link output in CU `xxxxxx0A` and the routing table should be prepared:

```
Nid|address |M | u    s | L    N |l w n g|sTO Err   Cent vTO hTO
(0) 0049C067      -  S00| -  R00|0 0 0 0| 15 SERV   OFF 304  30
(1) 690F000A    S00 S00|S03 R01|1 0 0 0| 15 SERV   OFF 304  30
```

Choose a fictive address belonging to CU `xxxxxxxx`, here `xxxxxx0B`. Fill in the routing table in CU `xxxxxx0A` properly (and also in the possible CUs on the way from Setr to `xxxxxx0A`).

```
Local retab. No 1
0B to:0A
690F000Ah>
```

Direct the `user` output in the `SIe` menu in `xxxxxx0A` to the node `xxxxxx0A`. Set `NO AR` in this channel.

```
(3) 0   NO AR        | 1   NO AR          usr OFF NONE
```

Set the local mode parameter in `xxxxxx0A`, `SPe` menu, MARS-A: `(l)oc:ON`

```
MARS-A parameters:
(a):1000ms  (r):5  (c)rc:OFF  (G)SM:0  no traffic t(i)meout:0sec
(t)el.:
Opposite retranslation address:00000000
(l)oc:ON  loc (s)ource:00000000
(R)emote Access:OFF
(q)uit
690F000Ah>
```

Type `!h0B Enter` and send `sts` or a different setr command, but no `!` command. The reply comes from `xxxxxx0B` and contains the source address `xxxxxx0A`.

Example - we have a standard connection from `690F0001` to `690F000A` from where we call via the local mode to `690F000B`:

```
690F000Ah>

u S00    690F0001     R01
29/ 72   690F000A   serd

 serd    690F000A     R01
30/ 72   690F0001  u S00
690F000Ah>!hb

690F000Bh>sts

690F000Bh>2906
690F000Ah>
```

Now prepare the required configuration in `xxxxxx0B` including the address, which can be still arbitrary.

If we want to continue the connection via routing through SCC, then add the retranslation output from SCC to the node to `xxxxxx0A` :

```
(3) 1   NO AR         | 1   NO AR         usr OFF NONE
```

Switch off the local mode in CU `xxxxxx0A`, `SPe 3t` menu : `(l)oc:OFF`

If we have added the necessary routing configuration to the destination CU then we can continue by the standard no-local mode:

```
690F000Bh>

u S00    690F0001     R01
29/ 71   690F000A     S03
  S02    690F000B   serd

 serd    690F000B     S02
  S03    690F000A     R01
29/ 71   690F0001  u S00
690F000Bh>
```

7. Time in MORSE

7.1. GMT and local time

Time in a MORSE CU appears in various forms:

- GMT — entries to the CU are stored and transferred in this form

- Local time — GMT time modified by CU time zone and by summer time

- Operator time — GMT time modified by PC time zone

- PC time — PC time including time zone and PC summer time

- Uptime — number of sec from starting CU

Individual times appear in these menus:

- GMT

  - (s)ervice (s)tatus

  - (E)vent log

  - in protocols such as Mars-A, Modbus, IEC, MAS

- Local time

  - (s)ervice (s)tatus

  - (s)ervice (t)ime

  - in protocols such as Mars-A, Modbus, IEC, MAS

- Operator time

  - d(i)ag (M)onitoring

  - d(i)ag stat (l)ogs

- PC time

  - start Setr

  - Alt+P, together with Setr parameters

- Uptime

  - (s)ervice (s)tatus

  - (s)ervice (t)ime (s)econds

  - d(i)ag (t)ests stat. (t)est

A general idea of time is provided by menu (s)ervice unit (s)tatus, which in addition to other information contains local time, uptime, GMT and a record of the last time entry to the CU:

```
 local time:2007-11-21 07:53:12 LOC; uptime:4944 sec
    day time:2007-11-21 06:53:12 GMT; log write at:86400
last update:2007-11-21 06:44:23 GMT
```

During the period of summer time the note "daylight savings" appear:

```
 local time:2007-05-01 08:00:53 LOC/daylight savings; uptime:5405 sec
    day time:2007-05-01 06:00:53 GMT; log write at:86400
```

Overview of times and where to use them:

```
                                              std,ste
                                                 |
                                                 v
                PC             -Zone-DST  <-  LOC
            ____|____          __
           |         |        |   v
           | time+dst+zone    |  GMT  +Zone+DST -> LOC
           |         _____|      |              |
           v         |   v            v              v
      start Setr    iM   ss          ss
      Alt+P         il   iE          std,ste
                         prot        prot
```
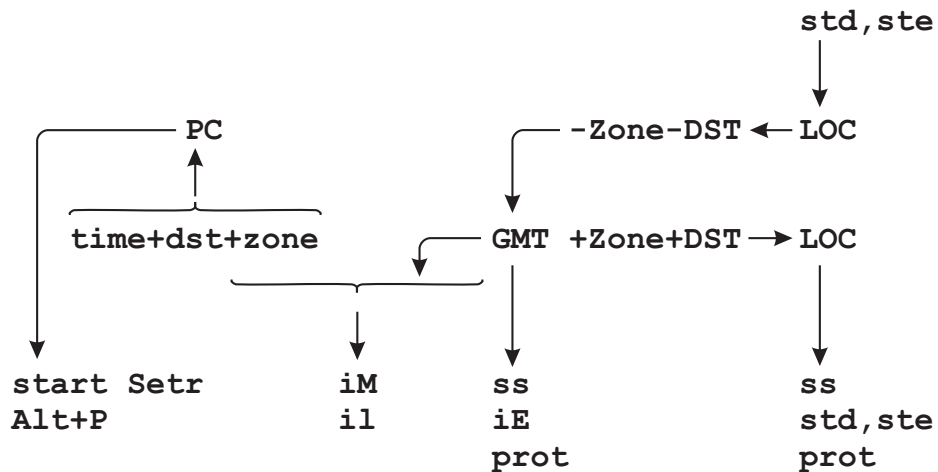
7.2. Inserting local time

An entry of local time LOC is done in menu (s)ervice (t)ime.

```
Time:
(d)ay time   (s)econds
set (n)ew time
dat(e)  set ne(w) date
```

The new local time entered using commands "stw" and "std" is adjusted according to the relationship given below by DI(F)F and DST and the GMT time obtained in this way is maintained in the CU internal clock.

If we enter a date here which changes the year it is necessary to restart the CU (sgB) or in "Ue" perform (I)nit and (S)ync or wait till midnight when the year will update automatically.

7.3. Summer time

GMT and local time are bound by the relationship:

```
GMT + DI(F)F + DST = LOC
```

GMT   world time maintained in the CU clock

DI(F)F   shift according to longitude, e.g. for central Europe 3600 s

DST   shift by 1 hour during summer time (daylight savings)

LOC   local time set in menu (s)ervice (t)ime

Values DI(F)F and DST are controlled from menu (U)nit (e)dit, which amongst other things contain :

```
Time (Z)one for DST:EU Time zone DI(F)F:3600sec
Summer time (all to zero - off):
start (1)month:3 (2)day:30
end   (3)month:10 (4)day:26
```

By selecting (Z)one (E)U in this menu we can switch on automatic use of summer time DST as well as annual automatic set-up of the correct date at the beginning and end of DST. In this case the item "obsolete(<605) Time (z)one" is invalid.

Alternatively by selecting (Z)one (N)ONE we can switch to manual mode and by selecting items (1), (2), (3), (4) we can select a fixed date at the beginning and end of DST. If we enter zeros here summer time is disabled.

Example of the transition to summer time.

Enter a time, for example, containing the year 2004:

```
stw01.01.2004
```

In menu "Ue" set automatic selection of dates for summer time (EU), local time shift 3600sec and run Init and Sync:

```
Ue Enter
Time (Z)one for DST:EU Time zone DI(F)F:3600sec
I  Enter
S  Enter
```

Then in menu "Ue" we can read the dates at the beginning and end of summer time:

```
Time (Z)one for DST:EU Time zone DI(F)F:3600sec
Summer time (all to zero - off):
start (1)month:3 (2)day:28
end   (3)month:10 (4)day:31
```

Enter the date and time right before the end of winter time:

```
stw28.03.2004
stn01:59:00
```

Now by repeatedly calling menu "ss" monitor the transition to summer time :

```
local time:2004-03-28 01:59:08 LOC; secs from cold start:19396
  day time:2004-03-28 00:59:08 GMT; log write at:105469

local time:2004-03-28 01:59:58 LOC; secs from cold start:19446
  day time:2004-03-28 00:59:58 GMT; log write at:105469

local time:2004-03-28 03:00:02 LOC/daylight savings; secs from cold
  day time:2004-03-28 01:00:02 GMT; log write at:105469
```

The transition took place at 01:00:00 GMT, when the difference between local time and GMT exceeded 1 hour.

If we want to monitor the transition from summer time to winter time, we would have to set the date to 31.10.2004, local time to 01:59:00 and wait 61 minutes until local time reaches 03:00:00 (i.e. 01:00:00 GMT). Then the local time returns to 02:00:01 (i.e. 01:00:01 GMT).

7.4. Synchronisation of time in the MORSE system

A precise source of time is available from :

- a receiver of DCF time signals

- GPS system receiver

- WALRUS sw running on a linux computer

- user protocols MARS-A, MODBUS, MAS, IEC 870-5-2(L&G) and others

- time can be entered manually from menu (s)ervice (t)ime

Synchronisation of time between adjacent CUs can be set up in "Ue":

```
Time sync:
 (i)n:1 Sr(c):690F5501 (p)eriod:3600
(O)ut:0 ds(t):00000000 p(e)riod:0
```

Time data can be periodically taken from an adjacent CU (1st row) or passed to another CU (2nd row). The first method allows for the synchronisation of more stations from one source.

The service is performed by the node determined by the selection `(i)n` or `(O)ut`, time data is requested from the CU `Sr(c)` or sent to the CU `ds(t)`, synchronisation repeats with a period `(p)eriod` or `p(e)riod`. Entry of the period (in seconds) activates the respective mode.

The source or destination address needs to be selected as a directly accessible address, i.e. without routing. The accuracy of synchronisation is in milliseconds.

During synchronisation GMT time is transferred, and in a synchronised CU the local time is derived according to menu `Ue`.

7.5. Minute impulse in CU

The minute impulse is a signal generated by the CU every minute for a period of 1 second. The signal is generated only in the case where function `(M)INP:ON is switched on in the menu Communication unit.`

```
Communication unit:
service (d)est:00000000 (N):0
(U)cc limit:130 * 0.1V  (h)yst.:2 * 0.1V
(s)tatus:0000 (P)SWD:OFF (L)OGW:OFF (M)INP:ON
```

The impulse is generated on the following pins:

type of modem	pin name	pin number	port	SW
MR25X **to** HW version 11	RxC	35	SCC2	version 630 and higher
MR25XS **to** HW version 11	RxC + CD	35 + 13	SCC2	version 630 and higher
MR25X HW version 12 and higher	CD	13	SCC2	version 630 and higher
MR400 and MR900, Cannon connector	CD	1(RS232)	SCC0	version 714 and higher

Note - the minute impulse is only generated on the whole minute. If there is a change in time in the CU the first delay between impulses will be truncated or extended in proportion to the change in time, for example:

• current time in CU: 10:00:30

• 30 seconds elapsed from beginning of last minute impulse

• time in CU is changed to : 11:11:10

• 50 seconds remain from beginning of new impulse

• in such a case the delay between impulses is 50+30 = 80 seconds

8. Secured packet transfer

The packet transfer is secured in this way; the receiving station checks the packet and sends an acknowledgement (ACK) about the error-free receiving of each packet. The transmitting station after obtaining this report regards the transfer to be completed. If it obtains the no-acknowledge (NAK) report about wrong packet receiving or if it does not obtain ACK for the designated time (timeout), then it sends the packet again and this transmission is repeated pertinently until the number of repetitions is exhausted (repeat).
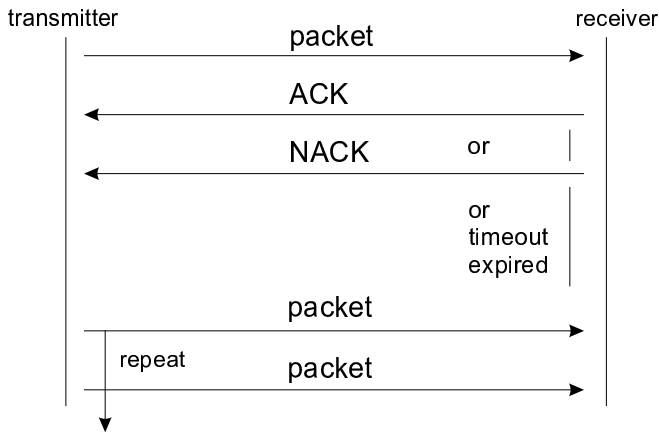
Fig. 8.1: Packet transfer

The security of transmission (to safeguard the packet) is pursued separately on every section of the route. The packet transmission between the user device and the SCC port is secured separately (according to attributes of protocol used) and the transmission on the individual sections of the MORSE route is also secured separately (according to the packet type setting).

The error free checking of packet transmitted is done in a way that the sending device does the given mathematical operation with the packet. The result, called checksum, is appended to the end of packet and then dispatch. The receiving device does the same operations with the packet and compares the result with the received checksum. If the checksums agree, then there is a high probability that an error didn't occur in the transmission and the message ACK is sent.

8.1. Security - parameters

Security in the user channel

The transmission between the user device and the SCC channel is secured according to protocol used. Some protocols (e.g. async.link) do not secure transmission, for this reason they are suitable only for lines which are very reliable. Some protocols allow the security to be switched on/off in their parameters (RDS), and others have the security always on (MARS-A). For a successful transmission, the link must have on both ends the same protocol with the same parameters set.

Security in the net and link MORSE channel

When the SCC channel receives the packet from external device, it adjustes it in the unified format for the MORSE network. This format contains among others the byte `packet type` with bit `security`. The security system is activated according to this bit, which secures the transmitting in each step through the MORSE network.

The SCC channel behaves according to parameter `sec` in the menu **SIe** , which can get the values
`ON`, `OFF`, `user` . These are set in the menu **SIe1u** by combination of parameters `user se(c)` and
`(s)ecurity`.

```
Channel to Node Interface:
   retranslation    |   user+service              lim
 id N  A t         m | N  A t Base     m  sec brc S   e
(0) 0   NO AR        | 1   NO AR           usr OFF NONE
(1) 0   NO AR        | 2 MASK 00000000/08 ON  OFF NONE
(2) 0   NO AR        | 1 MASK 00000000/08 OFF OFF NONE
(3) 0   NO AR        | 0 MASK 00000000/08 usr OFF NONE
```

Influence of `sec` parameter to the packet type setting:

```
parametr                        security    bit security
SIe1uc       SIe1us      SIe                 in packet type
user se(c):  (s)ecurity:  sec

  OFF            ON       ON    active      ON
  OFF            OFF      OFF   no active   OFF
  ON           OFF/ON     usr   according to packet type
                                in incoming packet
```

In the last case when `usr` is set in the SIe column, the security bit of resulting packet is set according
to the incoming packet type. The parameter `SIe1us` has not meaning here.

```
security bit:
incoming packet      resulting packet
   ON                ON
   OFF               OFF
   not included      ON
```

⚠ **Important**

Change in the default setting:

up to version fw 721 the parameter SIe sec = ON

from version fw 723 the parameter SIe sec = usr

The security bit in the packet type (visible in the monitoring **iMS, iMF**) then switches on/off the security
at the radio transmission. The repeat parameters for it are prepared in the menu **FPe** in paragraph
ACK.

```
RF channels:
    Access          |ACK              |coding |Mobile
 id a      del l num TO|fix var rep P hT|mod typ|base    mask   center  per
(0) NORMAL 16 16  4 10| 600 400  5   30|REP DBL|OFF
(1) NORMAL 16 16  4 10| 600 400  5   30|REP DBL|OFF
(2) NORMAL 16 16  4 10| 600 400  5   30|REP DBL|OFF
(3) NORMAL 16 16  4 10| 600 400  5   30|REP DBL|OFF
(4) NORMAL 16 16  4 10| 600 400  5   30|REP DBL|OFF
```

The timeout is set by the sum `fix+(0to3)var` [ms], where (`0to3`) is the random number protecting against blocking, when two CUs are sending concurrently. The max. number or repeats is set by parameter `rep`.

8.2. Secured transfer - examples

Next configuration is used for the illustration:

The node 690F1240 simulates the user equipment called here terminal, which sends the packets to the node 690F1241 belonging to MORSE network.
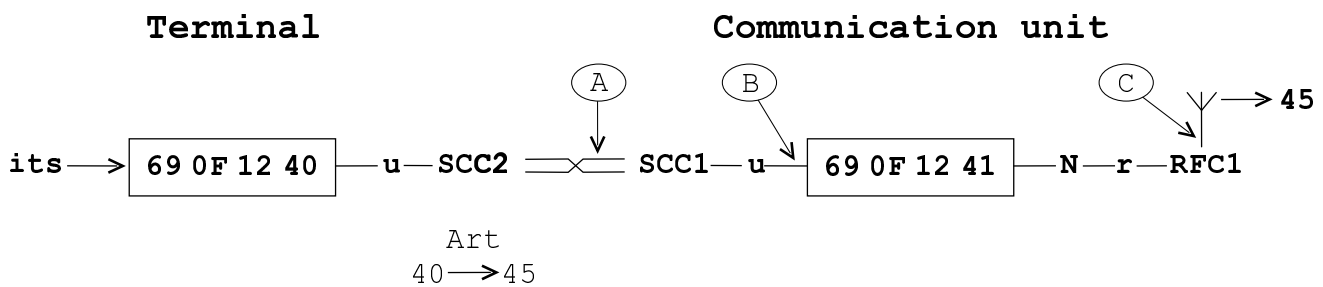
Terminal

From the menu **its** there is send to the node 40, the command which makes the node generate the packet and send it to the destination address 40. The node fulfills it and sends it at the next routing to it's `user` output, because the destination address is equal to it's own address.

The packet is given to the port SCC2, where is set the address changing by table Art1, which changes the destination address from 40 to 45. In the menu SPe there is set the protocol RDS, which parameters allows to check out several versions of security.

CU - Communication Unit

The packet addressed now to the destination 45 is given, by the crossed link, to the port SCC1. We follow the incoming packet in the point A by monitoring of SCC1. The packet MORSE is completed here and it is supplemented by packet type according to the parameter SIe1u sec. The resultant packet given to the node 690F1241 in the point B we can see by the iMSI monitoring.

The packet is sent from the node by channel RFC to the address 45. However it is out of reach and the ACK doesn't come. So we can see in the point C the work of repeated sending using the monitoring RFC.

In the terminal and in the CU is the protocol RDS used, in which parameters is set:

- (a):1000ms - timeout

- (r):1 - number of repeats

- (m) - form of check sum

- (c) - switching ACK on/off

Using the parameters (m) and (c) we can simulate various situation:

8.2.1. Link - checksum does not fit

Terminal generates the packets with different check sum, that is expected at CU, the ACK is off.

```
Terminal:                        Communication unit:
Parameters SCC2                   Parameters SCC1
  RDS parameters:                  RDS parameters:
  (a):1000  (r):1  (m):0000        (a):1000  (r):1   (m):FFFF
  (c) :OFF                         (c) :OFF
```

Monitoring in point A:

```
>>
13:55:08.222 rx;i    7 | S01
4445 0200 AAAA 00
```

SCC1 in CU accepted the packet, checked it according to check sum as wrong and so SCC1 didn't create the MORSE packet and didn't send it next in the node.

8.2.2. Link - missing ACK

The terminal generates again the packets with wrong crc but in this case expects the ACK.

```
Terminal:                        Communication unit:
Parameters SCC2                   Parameters SCC1
  RDS parameters:                  RDS parameters:
  (a):1000  (r):1  (m):0000        (a):1000  (r):1   (m):FFFF
  (c) :ON                          (c) :OFF
```

Monitoring:

```
>>
14:02:58.074 rx;i    7 | S01
4445 0200 AAAA 00
14:02:59.078 rx;i    7 | S01
4445 0200 AAAA 00
```

SCC1 in CU evaluated the packet as wrong, but it has not permitted the ack sending, so it sends to the terminal no ACK nor refusing NAK. This is why the terminal after passing timeout 1000 ms once repeats the sending (it is set `(r):1`).

8.2.3. Link OK, net security OFF

The terminal generates packet having the same crc as expects the CU. The parameter in CU in menu `SIe sec` is set to `OFF`.

```
Terminál:                        Communication unit:
Parameters SCC2                   Parameters SCC1
  RDS parameters:                  RDS parameters:
  (a):1000  (r):1  (m):FFFF        (a):1000  (r):1   (m):FFFF
  (c) :ON                          (c) :ON
```

Setting `SIe sec` for SCC1 is OFF:

```
Channel to Node Interface:
   retranslation      |   user+service              lim
 id N   A t           m | N  A t Base      m  sec brc S   e
(0) 0   NO AR         | 1   NO AR             usr OFF NONE
(1) 0   NO AR         | 1   NO AR             OFF OFF NONE
(2) 0   NO AR         | 1 MASK 00000000/08    usr OFF NONE
(3) 0   NO AR         | 0 MASK 00000000/08    usr OFF NONE
```

Monitoring:

```
>>
15:13:24.257 rx;i    7 | S01
4445 0200 AAAA 21
15:13:24.257 tx      1 | S01
06
15:13:24.257|                   |690F1245 690F1241|S01I   OUT   2||09 0user
AAAA
15:13:24.257|690F1245 690F1241|690F1245 690F1241|01D   RFTX    2 09 4dat
AAAA
```

After receiving the packet, the SCC1 send back the ACK = 06, so the terminal doesn't repeat the sending. SCC1 created the MORSE packet from succesfuly checked packet received from wire link. According to the parameter `sec=OFF` in menu **SIe** the packet got the type 09 as we can see in CNI monitoring of port S01. The packet type 09 contains the information, that the packet will go through the MORSE network unsecured. This is why the RF channel transmitted the packet to the address 690F1245 and in spite of it didn't become any ACK, the repeated transmission was not done.

We can see in the monitoring, that at creating the MORSE packet in the SCC1 channel was the data `AAAA` adopted from the original packet and the MORSE address 690F1245 was formulated from the short address 45. The others parts of original packet will be recreate in the SCC at the leaving the MORSE network and they are not transfered through the MORSE network.

8.2.4. Link OK, net security ON

The parameters of link connection between the terminal and the CU remain the same as previously. In this case is in the SCC1 in menu **SIe** set the parameter `sec=ON`.

In the menu **FPe** there are set the parameters for repeating on RF channel `fix=600, var=400, rep=2`:

```
RF channels:
   Access           |ACK                |coding |Mobile
 id a      del l num TO|fix var rep P hT|mod typ|base     mask    center  per
(0) NORMAL 16 16  4 10| 600 400  5   30|REP DBL|OFF
(1) NORMAL 16 16  4 10| 600 400  2   30|REP DBL|OFF
(2) NORMAL 16 16  4 10| 600 400  5   30|REP DBL|OFF
(3) NORMAL 16 16  4 10| 600 400  5   30|REP DBL|OFF
(4) NORMAL 16 16  4 10| 600 400  5   30|REP DBL|OFF
```

Monitoring:

```
>>
15:34:26.742 rx;i    7 | S01
4445 0200 AAAA 21
15:34:26.742|                  |690F1245 690F1241|S01I   OUT   2||89 0user
AAAA
15:34:26.742 tx      1 | S01
06
15:34:26.742|690F1245 690F1241|690F1245 690F1241|020   RFTX    2 89 7dat
AAAA
15:34:28.563|690F1245 690F1241|690F1245 690F1241|020   RFTX d  2 C9r7dat
AAAA
15:34:29.993|690F1245 690F1241|690F1245 690F1241|020   RFTX d  2 C9r7dat
AAAA
```

From the error free packet incommed through the link into SCC1 was the MORSE packet created. According to the parameter `sec=ON` it was defined as type 89 (secured) and in this state it was send to the node 690F1241. The node transmitted it through the RF channel. The ACK doesn't come, so the transmitting was repeated twice more according to the parameter `rep`.

The same effect would have the parameter `sec=usr` in the menu **Sle**, because the packet incomming through the protocol having no security information, is in SCC defined as secured. In other case, if in SCC would be used the MARS-A protocol carying the packet type information through the serial link, then the packet type defined in SCC1 would be done according to it.

8.2.5. Link OK, net OK

The CU 690F1245 was added. It receives the packet on RFC and sends the ACK.

```
>>
09:24:49.702 rx;i    7 | S01
4445 0200 AAAA 21
09:24:49.702|                  |690F1245 690F1241|S01I   OUT   2||89 0user
AAAA
09:24:49.703 tx      1 | S01
06
09:24:49.703|690F1245 690F1241|690F1245 690F1241|022   RFTX    2 89 1dat
AAAA
09:24:49.743|690F1241 690F1245|                  |022*31~ 96   0*06  ack
```

We can see in the monitoring, that the packet `4445 0200 AAAA 21` obtained from the terminal was acknowledged by sending `06`. The packet was modified to the MORSE form having the packet type `89` and sent into node. From the node was the packet sent through RF channel to the address 690F1245 and the ACK was received. By this actions was fulfilled the task of node 690F1241 and the next secured transmission of this packet is work for the next nodes.

9. Protocols
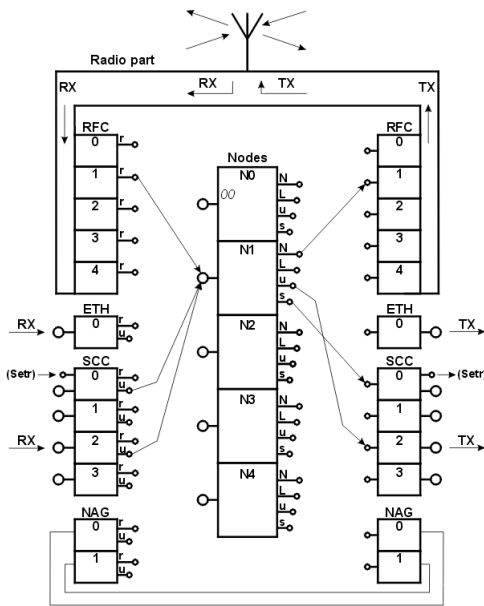
The CU diagram shows, that the packets from the user equipment comes into node through serial communication channel SCC0, 1, 2, 3 or ETH0. After passing through the MORSE network, they leave the last node again through SCC. Inside the MORSE network are used the packets in the MORSE form but the user equipment use packets in various forms. One of the tasks of SCC is to convert these packets into unified form suitable for the transfer through network and on its output adjust it again in users form. This function is defined in the protocols relevant to the various user equipment.

The protocols can be assigned individualy to each of SCC in the menu SPe, see MORSE firmware documentation, chapter SCC channels for more details. Each protocol uses its set of parameters, which contain the user's information for the function of the protocol. The protocols can be classified, roughly, according to their function:

- Mere asynchronous link between two points. For example: ASYNC.LINK, ASYNC LINK++

- The protocols furnished by address and checksum. This allows the connection between different points of network, they guarantee the error free data transmittion. For example: RDS

- Protocols containing additional information useful in the network like packet type, packet number, notice about repeated transmitting or some special services in the link layer. For example: MARS-A

- Protocols MASTER-SLAVE type. This numerous group defines one station as the central, which sends the questions to other stations and expects the answers from them. For example: MDU, MININET, MODBUS, S-BUS, COMLI, PR2000

- Protocol comunicated through Ethernet channel.

Some illustrational examples for function of individual groups will be shown here. More exact descriptions are on the pages www.racom.eu[1] in part Support, Software, Interface protocols. Next examples shows the form of packet at input into the MORSE network through SCC having appropriate protocol, next the packet in MORSE form outputting the SCC to the node and at last the packet outputting the destination CU through channel SCC.

---

[1] https://www.racom.eu/cz/support/protocol.html

9.1. ASYNC LINK protocol

This simple protocol uses only one parameter - MORSE address of opposite station:

```
ASYNC LINK parameters:
link destination
(a)ddress:1241h
(q)uit
```

The next monitoring shows the packet containing the data AAAA, which was accepted by SCC channel S02. Next it was sent from SCC2 into the node modified in the MORSE packet form with addresses (from right) `source` and `destination`. The packet is processed in the node (addresses `from` and `to` added) and transmitted through RF channel and at last it leaves MORSE network in the destination station through channel SCC1 with the original form AAAA.

```
>>
08:38:35.336 rxsim   2 | S02
AAAA

CNI mon     |toa        frm       |dst       src      |          size|TT N
08:38:35.337|                     |00001241 00001240|S02I  OUT    2||89 0user
AAAA

RF mon      |toa        frm       |dst       src      |lNo!DQ!RSS size|TT N
08:38:35.337|690F1241 690F1240|690F1241 690F1240|019  RFTX     2 89 0dat
AAAA

Monitoring: source 690F1241|6.
08:38:35.353 tx       2 | S01
AAAA
```

The address of opposite CU must be put in the parameter of protocol ASYNC LINK. This is why the data can be transfered only between in advance chosen pair of CU (see the name of protocol). The data transferred between the user equipment and SCC port are not checked on lost nor error free transfer.

9.2. RDS protocol

This protocol doesn't contain the address in its parameters, instead the address is contained in the incoming packet to SCC. It is the down part of destination address 41, more the packet contains the aid label 44, length of data 0200, checksum 25 and the data transfered AAAA. The data is the only part, which is transferred through the morse network, as we can see in second part of monitoring. The last part shows the packet leaving the MORSE network through SCC1 port.

```
>>
Monitoring: source 690F1240|7.
12:47:34.006 rxsim   7 | S02
4441 0200 AAAA 25
12:47:34.007|690F1241 690F1240|690F1241 690F1240|01C  RFTX     2 89 6dat
AAAA
```

```
Monitoring: source 690F1241|0.
12:47:34.039|690F1241 690F1240|690F1241 690F1240|01C*30* 65    2*89 6dat
AAAA
12:47:34.039 tx       7 | S01
4440 0200 AAAA 26
```

- One must say, that more information from input packet were transfered through MORSE network, in this case the address, which is the standard part of the MORSE packet. Transfer of this address through network in original input packet would be duplicated. Similarly duplicated would be the transfer of others part of input packet because it can be reconstructed by RDS protocol in output port SCC1.

- The comunication can be directed in different nodes, because the destination address is contained in the incoming packet. The user equipment should be able assemble the packet properly including the address and checksum.

- The checksum characterizes the state of packet at dispatch from the user equipment and according to it is checked the error free communication between outer equipment and the SCC port. In this illustrations are omitted the ACK messages, more about them in article Chapter 8, *Secured packet transfer*.

9.3. MARS-A protocol

The MARS-A protocol is equipped by all required functions. It contains in its head the address, the packet type, the repeated transmitting label, the numeration of packets transmitted and more. The example shows the dispatching of data AAAA to the address 690F1241. The second part shows the packet going from RFC to the antenna. The last one is the packet going out of the destination node through SCC1, which is adjusted in the MARS-A form.

```
Monitoring: source 690F1240|4.
13:09:03.750 rxsim  12 | S02
C008 0980 690F 1241 AAAA 186C

13:09:03.751|690F1241 690F1240|690F1241 690F1240|030  RFTX    2 89 0dat
AAAA

Monitoring: source 690F1241|3.
13:09:03.781|690F1241 690F1240|690F1241 690F1240|030*29* 66   2*89 0dat
AAAA

13:09:03.781 tx      12 | S01
F008 0900 690F 1240 AAAA 28ED
```

- The packet incoming into network through the port differs in its head and in checksum from the packet leaving the network, but the data is equal. The dissimilarity of head results from its function, e.g. the incoming packet contains the destination address, the outgoing packet contains the source address.

- The target address is not written among the parameters but it is contained in the packet incoming in MARS-A protocol from outer device and so the packets from connected terminal can be send to different targets in the network.

9.4. The data transfer between different protocols

Considering the fact, that the protocols converts the incoming packet to the unified MORSE form for transmission through the network and before outputing the packets converts again in the form required by outer device, it is possible to use different protocols on net input and net output. For example, the transport of data AAAA which was inputted by RDS protocol and outputted by MARS-A protocol looks like this:

```
>>
Monitoring: source 690F1240|7.
13:26:50.465 rxsim   7 | S02
4441 0200 AAAA 25


13:26:50.466|690F1241 690F1240|690F1241 690F1240|03D  RFTX     2 89 7dat
AAAA

Monitoring: source 690F1241|4.
13:26:50.498|690F1241 690F1240|690F1241 690F1240|03D*29* 67    2*89 7dat
AAAA

13:26:50.498 tx     12 | S01
C008 0907 690F 1240 AAAA 18EA
```

This feature can be used for creating the exchange, which proceeds the data from various CU equipped by different protocols.

9.5. Service access

Upon communication between Setr and the CU over the service cable a SERVICE connector is used. This works over the SCC0 channel and MARS-A protocol.

After connecting CU to the PC with a service cable protocol MARS-A is set automatically to SCC0. For the duration of the service connection user communication on SCC0 is interrupted.

After disconnecting the service cable the original protocol settings and user communication on SCC0 are automatically restored.

Note

Radio modem MR25 uses channel SCC2 for service access

10. Services

10.1. Service 0x18 Echo

The Echo packet (! command) goes throught the network to the destination address and back. On each addresses is attached 8 bytes describing the way in the node and out of it.

Request format:

```
| serNo/16 | type/16 |
```

Response format:

```
| serNo/16 |
| prefix/3 | par1/5 | par2/8 |        |
| addr/32  |                          | added for each address
| prefix/3 | par1/5 | par2/8 |        |
```

Items meaning:

serNo/16   E018 - service number

type/16   This item is added in the version 9.0.28.0 and higher. It distinguishes the echo packet from statistical test and from the exclamation mark command. Allows the concurrent aplication of both this commands.

   0001 - Echo paket generated from the statistical test
   0002 - Echo paket generated by the exclamation command "!"

addr/32   MORSE address of the visited node

prefix/3

value	visible on 4 bites	meaning
0	0	obsolete
1	2	direction in the node
2	4	direction out of node
3	6,7	packet incomming via RFC
4	8	serd (service dispatcher, turning point of the route)
6	C	user (beginning/end of the route)

Meaning of next two items depends up the prefix value:

For prefix = 1, 2, 6 :

par1/5

value	meaning
1	SCC
2	RFC
3	ETH

  4   NAG

  F   interconnection (direct connection between nodes)

par2/8 number 0 to 4 - CNI id (e.g. SCC can have id from 0 to 3)

    par2/8 has no significancy for the case when par1/5 = F

For prefix = 3 :

par1/5 DQ of the incomming RF signal

par2/8 RSS of the incomming RF signal

For prefix = 4 :

par1/5 has no significancy

par2/8 has no significancy

Items format overview:

prefix/3	par1/5	par2/8
0 obsolete		
1 into node 2 out of node 6 user	1 SCC	
	2 RFC	channel No.
	3 ETH	
	4 NAG	
	F inter	no significancy
3 rf	DQ	RSS
4 serd	no significancy	

The packet types

- Echo with trace, secured packet

  Request: 0x98

  Response: 0x9A

- Echo with trace, unsecured

  Request: 0x18

  Response: 0x1A

- Echo without trace, unsecured

  Request: 0x10

  Response: 0x12

Examples:

The examples are valid for Setr 9.0.28.0 and higher. The previous versions use a shorter packets where the item type/16 = 0x0002 is missing.

Echo packet as result of the ! command:

packet type 0x98, data sent 0x**E018 0002** ...

```
>>!h22

690F0022h>!

690F0022h>
u S00   690F0011    R01
25/ 84  690F0022   serd

 serd   690F0022    R01
31/ 82  690F0011  u S00
690F0022h>
13:22:05.050|690F0022 690F0011|690F0022 690F0011|14F  RFTX    12 98 4dat 0
E018 0002 C100 690F 0011 4201
13:22:05.096|690F0011 690F0022|                 |14F*31~ 82   0*06  ack
13:22:05.164|690F0011 690F0022|690F0011 690F0022|153*31* 82   28*9A 4dat 0
E018 0002 C100 690F 0011 4201 7954 690F 0022 8000 8000 690F 0022 4201
13:22:05.164|690F0022 690F0011|                 |153  RFTX     0 06  ack
```

Echo packet generated using the Send packet test:

packet type 0x**98**, data sent 0x**E018 0002**

```
Send packet: (N):1   (d):690F0022h
(t)ype:0098h
s(o)urce:690F0011h
d(a)ta:....                   ...0xE018 0002
random data (l)ength:0byte
(r)epeat period:0ms + (j)itter:0ms
IP (P)ing
(s)tart r(e)port sto(p)
(q)uit
>>s

>>O.K.
>>

 test   690F0011    R01
26/ 72  690F0022   serd

 serd   690F0022    R01
30/ 71  690F0011  u S00
>>
13:40:46.367|690F0022 690F0011|690F0022 690F0011|15E  RFTX    12 98 4dat 0
```

```
E018 0002 A000 690F 0011 4201
13:40:46.414|690F0011 690F0022|                         |15E*31~ 71    0*06  ack
13:40:46.497|690F0011 690F0022|690F0011 690F0022|160*30* 71   28*9A 4dat 0
E018 0002 A000 690F 0011 4201 7A48 690F 0022 8000 8000 690F 0022 4201
13:40:46.498|690F0022 690F0011|                         |160  RFTX     0 06  ack
```

Echo packet generated using the Send packet test:

packet type 0x**10**, data sent 0x**E018 0002**

```
Send packet: (N):1    (d):690F0022h
(t)ype:0010h
s(o)urce:690F0011h
d(a)ta:....                        ...0xE018 0002
random data (l)ength:0byte
(r)epeat period:0ms + (j)itter:0ms
IP (P)ing
(s)tart r(e)port sto(p)
(q)uit
>>s

>>O.K.
>>
13:50:32.623|690F0022 690F0011|690F0022 690F0011|163  RFTX    4 10 5dat 0
E018 0002
13:50:32.749|690F0011 690F0022|690F0011 690F0022|167*31* 73   4*12 5dat 0
E018 0002
```

Echo response contained in the MARS-A packet:

```
13:53:45.244 tx    14 | S03
F00A 1200 690F 0022 E018 0002 6B3D
```

Echo packet generated using the Statistical test:

packet type 0x10 also RSS (m)easure:OFF, sec(u)rity:OFF
data sent 0x**E018 0001** ...

```
>>
14:02:52.399|690F0022 690F0011|690F0022 690F0011|17B  RFTX   10 10 2dat 0
E018 0001 0004 FFFB AAAA
14:02:52.474|690F0011 690F0022|690F0011 690F0022|17B*31* 72  10*12 2dat 0
E018 0001 0004 FFFB AAAA
```

Format description valid for fw 9.0.28.0.

10.2. Packet type

The packet type is a parameter length 1 byte characterizing the packet. It influences the packet processing in the node.

The packet type presented are valid for the communication protocols (MARS-A, MARS-U, MAS, slip, ppp, ethernet). The packet type used in the MORSE retranslations channels is slightly different, e.g. in the broadcast bit.

User packet types:

`|S/1|B/1|H/1|NT/5|`

Meaning of items:

S/1   security

B/1   broadcast

H/1   handicap/priority

       0   high priority
       1   low priority

NT/5   network type

       meaning of item NT:

       0x00   reserved
       0x01   reserved
       0x02   reserved
       0x03   reserved
       0x04   reserved
       0x05   reserved
       0x06   reserved
       0x07   reserved

       0x08   reserved
       0x09   USER DATA C1 (CHANNEL 1)
       0x0A   USER DATA C2 (CHANNEL 2)
       0x0B   reserved
       0x0C   Network message (former PACK ERROR)
       0x0D   reserved
       0x0E   reserved
       0x0F   MONITORING

       0x10   SERVICE REQUEST
       0x11   reserved
       0x12   SERVICE REPORT
       0x13   reserved
       0x14   reserved

0x15   PATH - packet having predefined trace

0x16   reserved

0x17   reserved

0x18   SERVICE REQUEST+TRACE; (see 0x10)

0x19   reserved

0x1A   SERVICE REPORT+TRACE; (see 0x12)

0x1B   reserved

0x1C   reserved

0x1D   PATH+TRACE; (see 0x15)

0x1E   reserved

0x1F   reserved

TRACE is a compilation of trace passed by the packet

Examples

The packets incomming from SCC0 to Setr via MARS-A protocol are monitored. The 3rd byte contains the packet type.

Packet type 0x09 USER DATA

The packet of type 0x09 received from address 690F0003:

```
2007-06-11 06:44:20.933  rx1 12
C008 0902 690F 0003 AAAA 0AAC
```

Packet type 0x90 SERVICE REQUEST, secured

Packet type 0x92 SERVICE REPORT, secured

Service request sts of type 0x90 is sent to address 690F0002, the report of type 0x92 came:

```
690F0002h>sts

690F0002h>
2007-06-11 06:42:56.762  tx1 14
E00A 9081 690F 0002 E00A 7300 8A8C

2007-06-11 06:42:56.882  rx1 16
C00C 9201 690F 0002 A00A 3436 3633 990F
```

Packet type 0x98 SERVICE REQUEST+TRACE, secured

Packet type 0x9A SERVICE REPORT+TRACE , secured

Echo packet ! is sent to address 690F0002:

```
690F0002h>!

690F0002h>
2007-09-05 11:03:55.60   tx1 14
F00A 9886 690F 0002 E018 0002
E19B

2007-09-05 11:03:55.220  rx1 46
C02A 9A06 690F 0002 E018 0002
C100 690F 0001 4201 7E50 690F 0002 8000
8000 690F 0002 4201 7C52 690F 0001 C100
D139

u S00    690F0001     R01
30/ 80   690F0002     serd

 serd    690F0002     R01
28/ 82   690F0001   u S00
690F0002h>
```

Setr version 9.0.27.0 and lower uses for Echo the word E018 instead of newer E018 0002.

Packet type 0x15 PATH

Service request sts is sent using path packet to address 690F0002:

```
path  690F0002h>sts

2007-06-11 06:43:49.778  tx1 26
C016 1580 690F 0001 8200 690F 0001 690F 0002 0010 E00A 7300 AD81

2007-06-11 06:43:49.919  rx1 28
E018 1500 690F 0001 8201 690F 0002 690F 0001 0012 A00A 3437 3136 BB0D
```

Packet type 0x1D PATH+TRACE

Echo packet ! is sent using path packet to address 690F0002:

```
2007-09-05 11:43:24.504  tx1 26
F016 1D80 690F 0001 8200 690F 0001 690F 0002 0018 E018 0002
E699

2007-09-05 11:43:24.270  rx1 58
C036 1D00 690F 0001 8201 690F 0002 690F 0001 001A E018 0002
C100 690F 0001 4201 7E4E 690F 0002 8000
8000 690F 0002 4201 7D4F 690F 0001 C100
D53B

u S00    690F0001     R01
30/ 78   690F0002     serd

 serd    690F0002     R01
```

```
29/ 79  690F0001  u S00
path  690F0002h>
```