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Railway Wireless Communication Network in the Czech Republic

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Content

- Aims
- Architecture
- Application Current Position of the railway vehicle
- Intelligent functions – Dynamic DNS
- RCN Manager
- Present use
- Near future
- Conclusion

History – before 2008

- The growing needs for data communication with the railway vehicles
- Existence of the 3 independent application with individual solutions for data communication
- Concepts of the new applications
 - Electronic train timetables
 - Active parking of electric units 471 series
 - Passenger information systems
 - Diagnostic systems of rail vehicles

RWCN

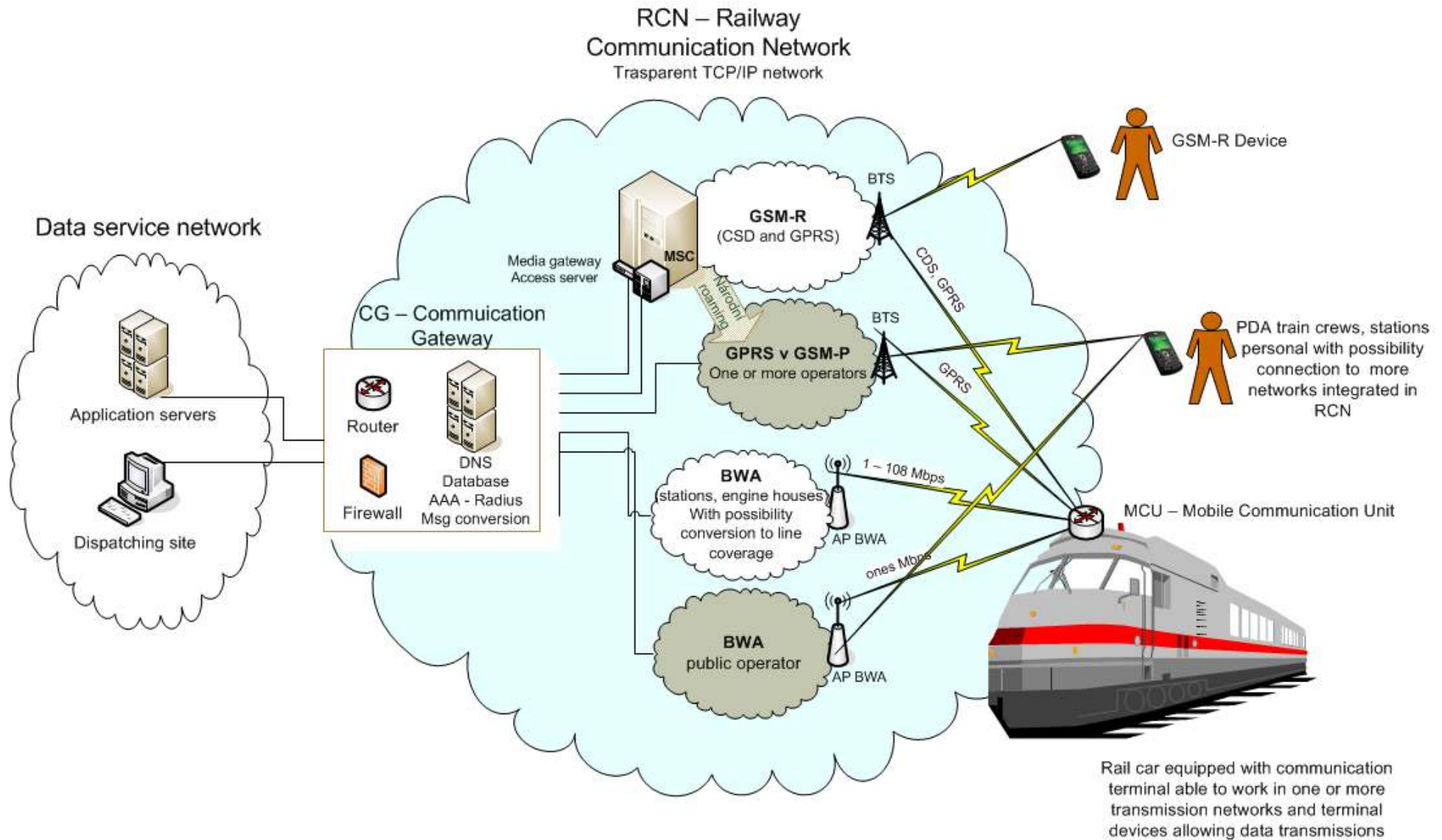
- RWCN (Railway Wireless Communication Network, originally Železniční bezdrátová přenosová síť) is the name of the network used for a data communication among mobile objects and infrastructure systems in the railway environment, especially for train to ground communication.
- RWCN consists of
 - transmission networks
 - mobile communication devices (terminals)
 - ground (central) communication gateway
 - interfaces, protocols and rules for wireless communication among users, devices and ground systems

Aims

- Perspective long-term solutions for the railway environment in the Czech Republic
- Usability for all subjects/companies in the railway environment
- Upgradeable for new applications, communication terminals and devices and for new upcoming standards
- Expandable to other types of transmission networks (e.g. CDMA, 3G, LTE, WiMAX)

Basic technical requirements

- Transparent IP communication
- Intelligent addressing of devices based on device names, UIC car codes, order or a function of an engine on the train and the train number
- Possibility of using encryption algorithms
- Definition of security rules
- Definition of quality parameters (QoS)
- Automatic selection of a suitable transmission network without manual operator intervention (based on the network availability or demand for a bandwidth)
- Possibility of integration up to thousands of devices of different types
- Minimizing redundant data transfers



Transmission Networks

- Public GSM networks (one or more operators), GPRS, EDGE
- Public broadband mobile networks (e.g. CDMA, 3G, WiMAX, LTE)
- GPRS technology in GSM-R network
- or broadband transmission network established for needs of railways (e.g. LTE, WiMAX)

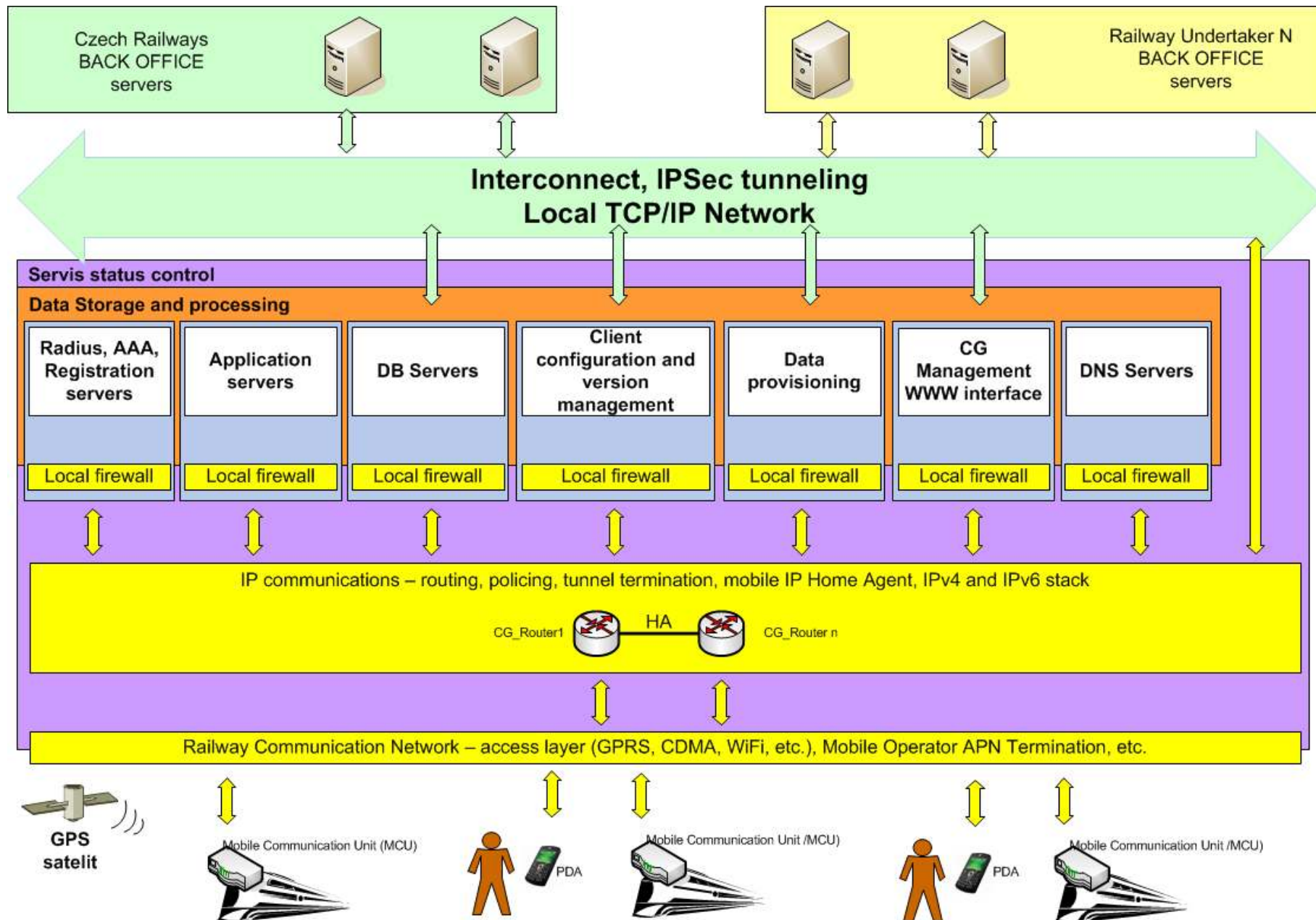
Combination of more mobile technologies is the way for delivery of required services

Gateway

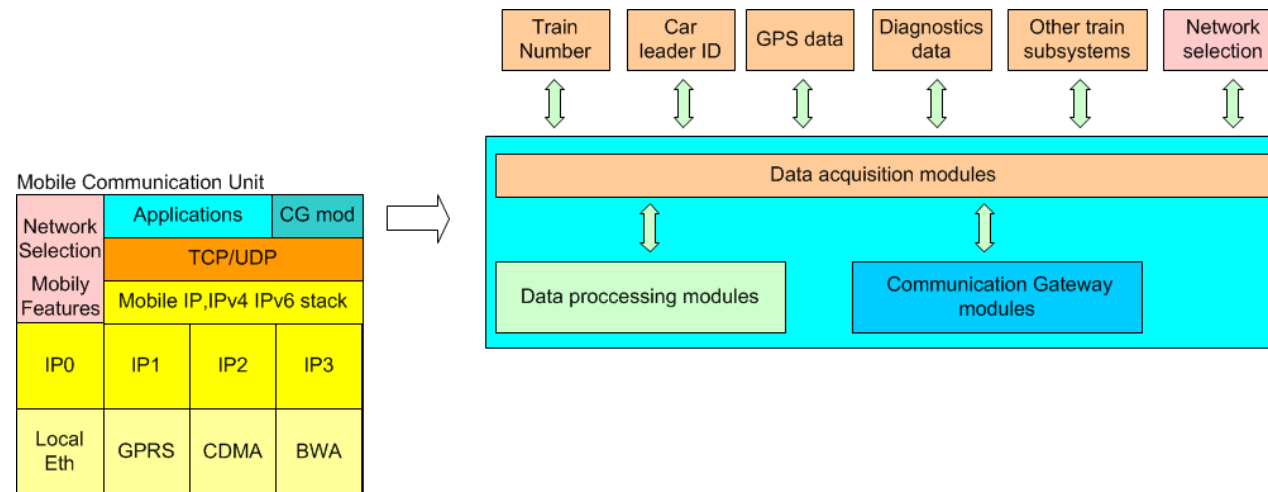
RWCN Gateway provides intelligent services:

- Dynamic DNS provides translation of hostnames to IP addresses
- Termination of tunnels for ensuring transparent IP communication with terminals through var
- RADIUS server for IP address assigning, authentication, authorization and accounting
- Transferring of data obtained from messages of the railway vehicle's location to all applications that require this kind of information

Gateway – logical schema



Terminals



Communication terminals ensure:

- communications of end devices located on the railway vehicle through RWCN
- automatic selection of the transmission network based on predefined algorithms (such as network availability, type of network) – not used yet
- Network Address Translation between LAN and RWCN
- establishing IP tunnels
- safety and compliance with QoS

Communication terminals can be standalone devices, optional modules, vehicle radios or other equipment components (smartphones ...).

Application Current Position of the railway vehicle

- The application is installed in the communication terminals of railway vehicles.
- Position data are sent in fixed time intervals or immediately after change of the vehicle status (like stopping or starting) to stationary information systems.
- To transmit these reports, the UDP protocol was chosen because of its minimal data transmission bandwidth.
- Frequency and rules of sending messages can be remotely configured.

Application Current Position of the railway vehicle

- Current Position message contains
 - message number (cyclically from 0 to 255),
 - number of vehicle in UIC number format,
 - current status of the vehicle,
 - current date and time recorded from a GPS receiver (in UTC format),
 - latitude and longitude,
 - speed,
 - azimuth,
 - network used by cab radio (150 MHz TRS, TRS 450 MHz, GSM-R, GSM-P),
 - train number,
 - engine function on train.
- Central gateway uses the received data about the vehicle location for ensuring some intelligent functions of RWCN, mainly for DDNS hostnames to IP translation and provides this location data to other applications.

Dynamic DNS

- For a proper function of a translation hostnames of devices to IP addresses is necessary to ensure the dynamic behavior of the DNS server. DNS server is part of the RWCN gateway and is based on the Oracle database server.
- Changes in assignment of railway vehicles to specific trains and their functions at these trains are saved into database. These information are extracted from messages about the Current Position of the railway vehicle.
- In addition, the database stores information about all devices installed on railway vehicles and their IP addresses.

Hostnames in RWCN

Structure of DNS hostname:

[device].[vehicle].[consist].[train].[operator].rcn

- [device]** – device name,
- [vehicle]** – UIC car code or position of the car on the train,
- [consist]** – only for compatibility reasons,
- [train]** – number or name of the train,
- [operator]** – constant „czechrailways“,
- rcn** – constant „rcn“.

Examples of addressing at RWCN

- DNS name of the communication terminal of the railway vehicle with UIC car code:

mcu.UIC515439410488.nuCst.nuTrain.czechrailways.rcn

- After logging engine on the train No. 210 (with UIC car code):

mcu.UIC515439410488.nuCst.tr210.czechrailways.rcn

- Leading engine of the train number 210:

mcu.engine01.nuCst.tr210.czechrailways.rcn

- Other devices located in the same vehicle e.g.:

mat.engine01.nuCst.tr210.czechrailways.rcn

tachograph.UIC515439410488.nuCst.tr210.czechrailways.rcn

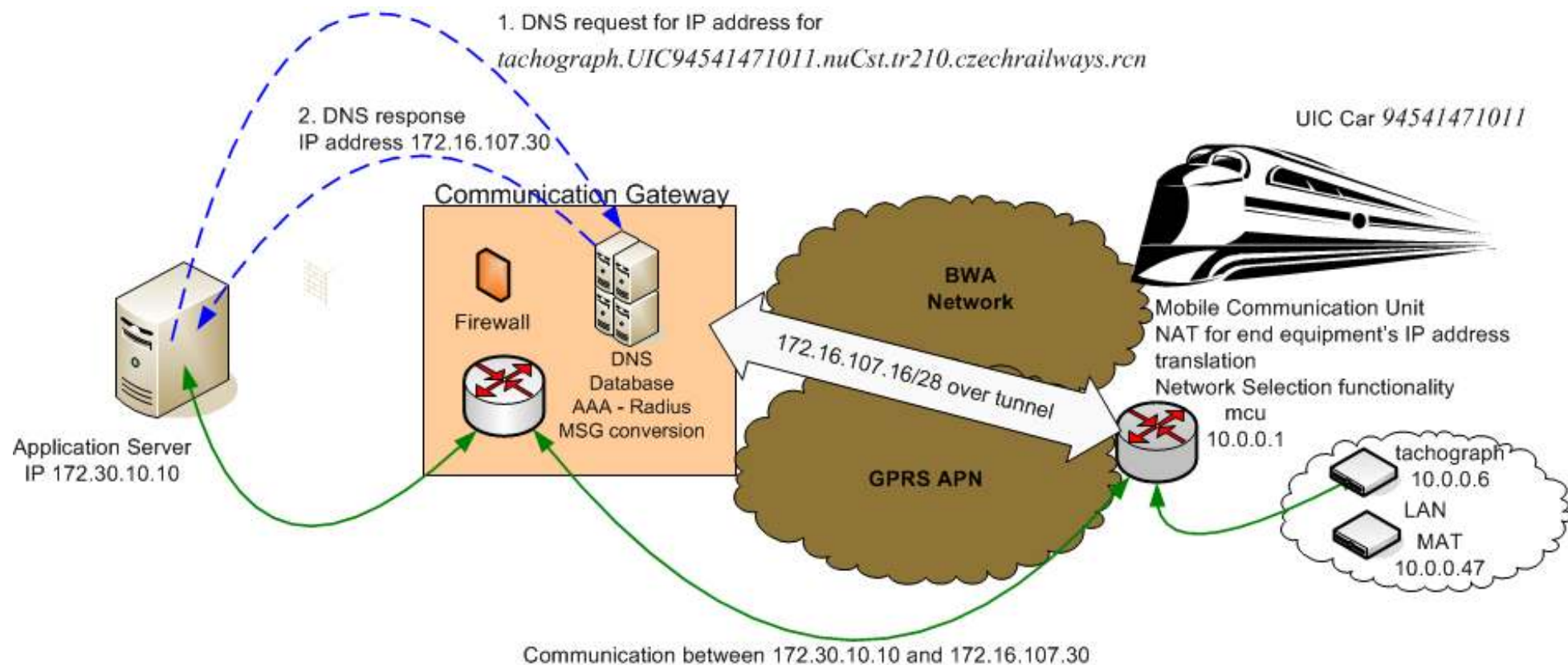
Railway vehicle devices addressing

- IP address of a specific network interface of the communication terminal is usually quasistationary assigned by the RADIUS server.
- To the communication terminal can be assigned (for terminals that allow this) network with mask /28, in which is 14 usable IP addresses for addressing of specific devices.
- For simple communication terminals are expected to use only a single transmission network (e.g. GSM-P) and a single IP address (the address of the network interface).

IP tunnels

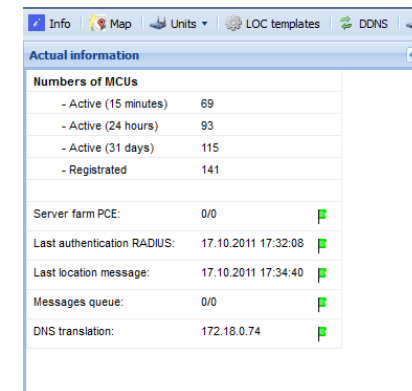
- IP tunnels are used to ensure the routing of IP subnets assigned to the communication terminals over different transmission networks.
- GRE tunnels (Generic Routing Encapsulation) are used in cases where it is possible to assign a static IP address for network interface of communication terminal.

IP communication with devices on trains

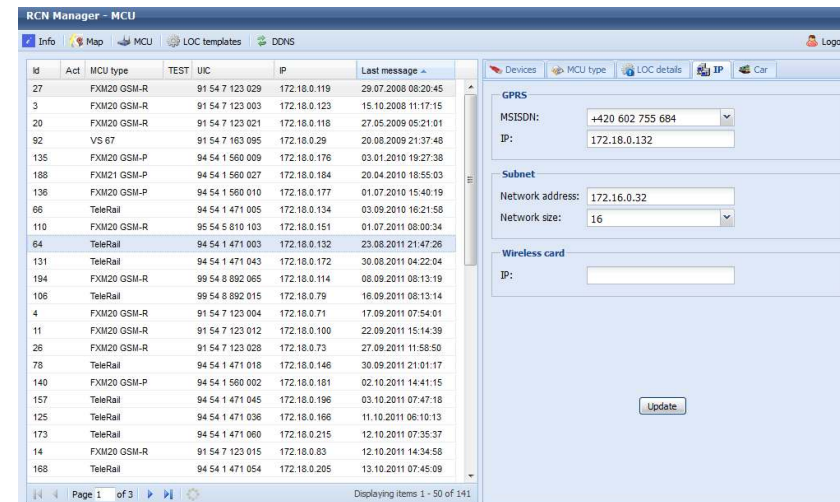


RCN Manager – software for management of RWCN

- Supervision of gateway services
- Management of SIM cards, mobile users, user groups
- Management of terminals, IP addresses, subnets
- DDNS configuration
- Logs from the RADIUS server - Authentication, Authorization, and Accounting
- Configuration of Application Current Position of the railway vehicle
- Map view with vehicle location



Actual information	
Numbers of MCUs	
- Active (15 minutes)	69
- Active (24 hours)	93
- Active (31 days)	115
- Registered	141
Server farm PCE:	0/0 ■
Last authentication RADIUS:	17.10.2011 17:32:08 ■
Last location message:	17.10.2011 17:34:40 ■
Messages queue:	0/0 ■
DNS translation:	172.18.0.74 ■

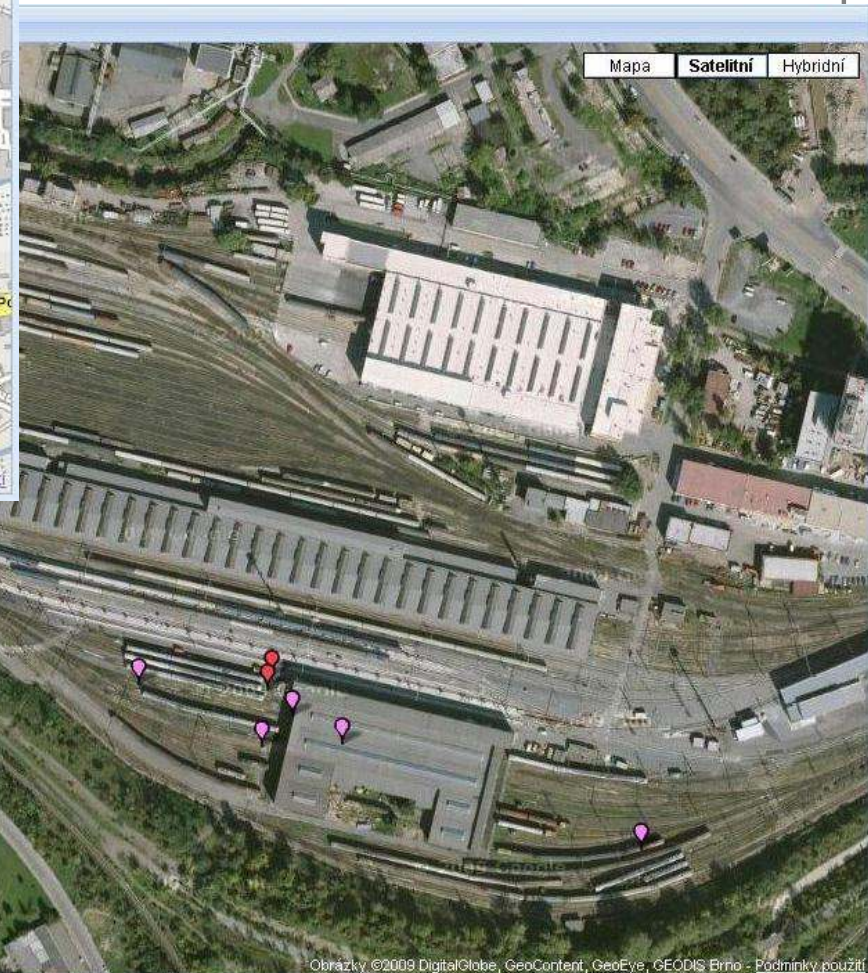
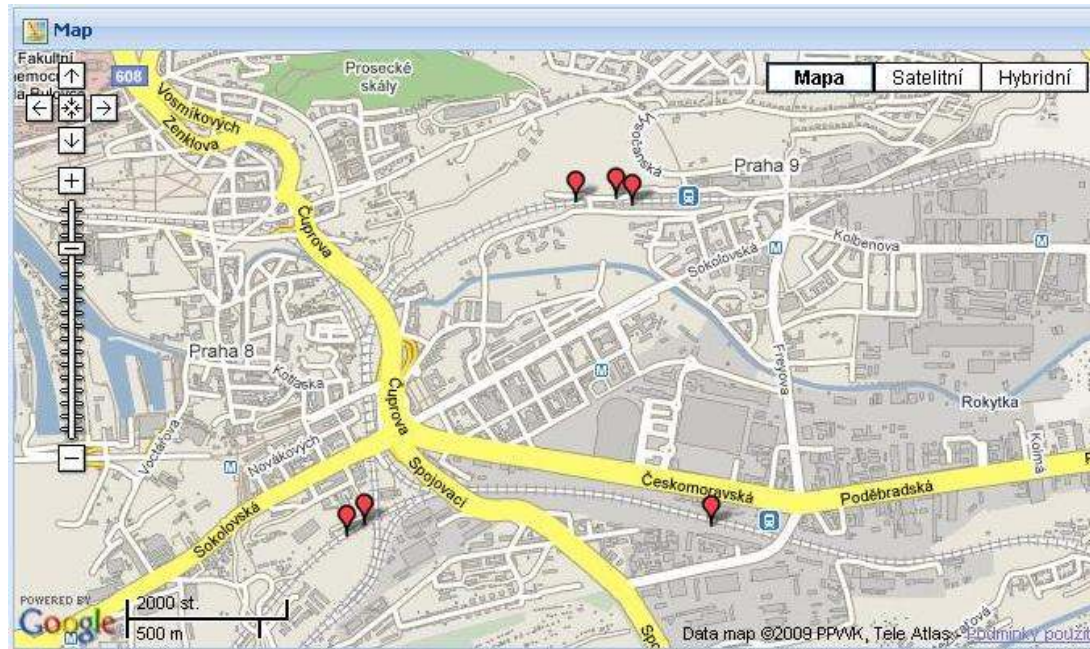


Id	Act	MCU type	TEST	UIC	IP	Last message
27		FXM20 GSM-R		91 54 7 123 029	172.18.0.119	29.07.2008 08:20:45
3		FXM20 GSM-R		91 54 7 123 003	172.18.0.123	15.10.2008 11:17:15
20		FXM20 GSM-R		91 54 7 123 021	172.18.0.118	27.05.2009 05:21:01
92		VS 67		91 54 7 163 095	172.18.0.29	20.08.2009 21:37:48
135		FXM20 GSM-P		94 54 1 560 009	172.18.0.176	03.01.2010 19:27:38
188		FXM21 GSM-P		94 54 1 560 027	172.18.0.184	20.04.2010 18:55:03
136		FXM20 GSM-P		94 54 1 560 010	172.18.0.177	01.07.2010 15:40:19
66		TeleRail		94 54 1 471 005	172.18.0.134	03.09.2010 16:21:58
110		FXM20 GSM-R		95 54 5 810 103	172.18.0.151	01.07.2011 08:00:34
64		TeleRail		94 54 1 471 003	172.18.0.132	23.08.2011 21:47:26
131		TeleRail		94 54 1 471 043	172.18.0.172	30.08.2011 04:22:04
194		FXM20 GSM-R		99 54 8 892 065	172.18.0.114	08.09.2011 08:13:19
106		TeleRail		99 54 8 892 015	172.18.0.79	16.09.2011 08:13:14
4		FXM20 GSM-R		91 54 7 123 004	172.18.0.71	17.09.2011 07:54:01
11		FXM20 GSM-R		91 54 7 123 012	172.18.0.100	22.09.2011 15:14:39
26		FXM20 GSM-R		91 54 7 123 028	172.18.0.73	27.09.2011 11:58:50
78		TeleRail		94 54 1 471 018	172.18.0.146	30.09.2011 21:01:17
140		FXM20 GSM-P		94 54 1 560 002	172.18.0.181	02.10.2011 14:41:15
157		TeleRail		94 54 1 471 045	172.18.0.196	03.10.2011 07:47:18
125		TeleRail		94 54 1 471 036	172.18.0.166	11.10.2011 08:10:13
173		TeleRail		94 54 1 471 060	172.18.0.215	12.10.2011 07:35:37
14		FXM20 GSM-R		91 54 7 123 015	172.18.0.83	12.10.2011 14:34:58
188		TeleRail		94 54 1 471 054	172.18.0.205	13.10.2011 07:45:09

GPRS	
MSISDN:	+420 602 755 684
IP:	172.18.0.132
Subnet	
Network address:	172.16.0.32
Network size:	16
Wireless card	
IP:	
<input type="button" value="Update"/>	

RCN Manager – Map view

Electric units 471 series
on map of Prague and satellite map
of train depot station Praha-jih



RCN Manager – Map view with details

RCN Manager - Map

Home Map MCU LOC templates DDNS Logout

Tree

Trains Engines

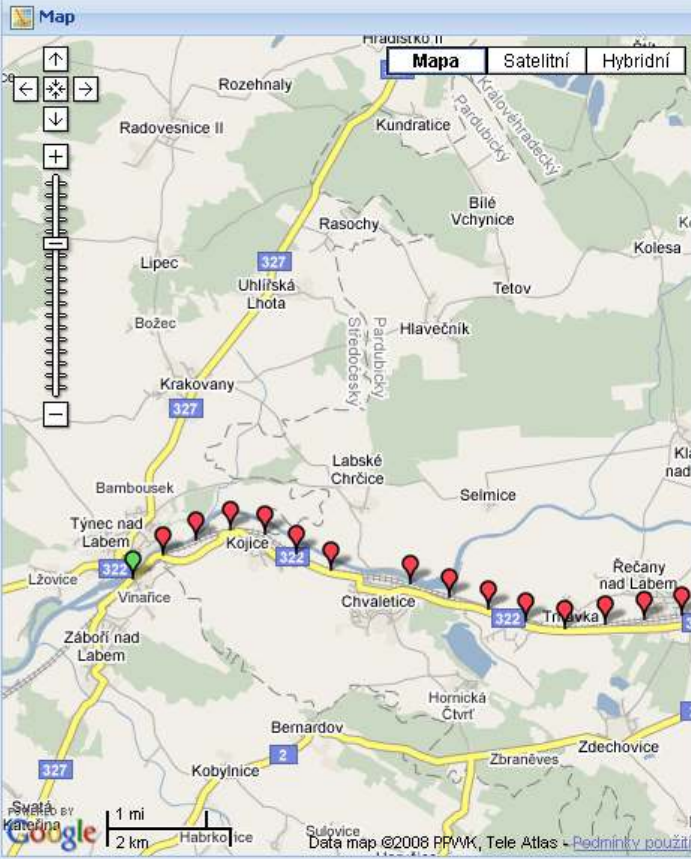
Active only

- CZ
 - 123
 - 123.004
 - 123.005
 - 123.006
 - 123.007
 - 123.008
 - 123.010
 - 123.011
 - 123.014
 - 123.015
 - 123.016
 - 123.017
 - 123.018
 - 123.019
 - 123.020
 - 123.022
 - 123.023
 - 123.024
 - 471
 - 471.012
 - 471.039
 - 892
 - 892.015

Table

Local time	Train No.	Speed	Status	Δ time	Δ distance
19.09.2008 08:36:40	48738	75	^t	00:00:30	621
19.09.2008 08:36:10	48738	73	^t	00:00:30	598
19.09.2008 08:35:40	48738	70	^t	00:00:30	578
19.09.2008 08:35:10	48738	69	^t	00:00:30	570
19.09.2008 08:34:40	48738	72	^t	00:00:30	608
19.09.2008 08:34:10	48738	75	^t	00:00:30	630
19.09.2008 08:33:40	48738	78	^t	00:01:00	1328
19.09.2008 08:32:40	48738	81	^t	00:00:30	669
19.09.2008 08:32:10	48738	80	^t	00:00:30	659
19.09.2008 08:31:40	48738	79	^t	00:00:30	654
19.09.2008 08:31:10	48738	78	^t	00:00:30	646
19.09.2008 08:30:40	48738	78	^t	00:00:30	646
19.09.2008 08:30:10	48738	78	^t	00:00:30	646
19.09.2008 08:29:40	48738	77	^t	00:00:30	636
19.09.2008 08:29:10	48738	76	^t	00:00:30	619
19.09.2008 08:28:40	48738	73	^t	00:00:30	601
19.09.2008 08:28:10	48738	71	^t	00:00:30	576
19.09.2008 08:27:40	48738	68	^t	00:00:30	564
19.09.2008 08:27:10	48738	69	^t	00:00:30	585
19.09.2008 08:26:40	48738	72	^t	00:00:30	609
19.09.2008 08:26:10	48738	74	^t	00:00:30	623
19.09.2008 08:25:40	48738	76	^t	00:00:30	645
19.09.2008 08:25:10	48738	79	^t	00:00:30	657
19.09.2008 08:24:40	48738	80	^t	00:00:30	657
19.09.2008 08:24:10	48738	80	^t	00:00:30	656
19.09.2008 08:23:40	48738	78	^t	00:00:30	635
19.09.2008 08:23:10	48738	74	^t	00:00:30	608
19.09.2008 08:22:40	48738	72	^t	00:00:30	605
19.09.2008 08:22:10	48738	73	^t	00:00:30	605
19.09.2008 08:21:40	48738	75	^t	00:00:30	622
19.09.2008 08:21:10	48738	75	^t	00:00:30	621

Map



Detail

19.09.2008 08:36:40	75 km/h moving, time exc
UIC: 91 54 7 123 008	Delta: 00:00:30 621 m
Car: CZ 123.008	Location: 50,03757 15,35935
Train: CZ 48738	Cab radio: 160 MHz
Function: engine1	Driver code:

Filter

Engine

UIC: 91 54 7 123 008

Train

Train No.:

Country:

Date & time

From: 19.9.2008 00:00

To: 19.9.2008 23:59

Status message

Speed:

Time:

Distance:

Threshold:

Delay:

Info:

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Present use

- Integration of the public GSM network (O2) – data services 3G, EDGE, GPRS
- Functional addressing of terminals and other devices on trains using DDNS
- About 150 vehicles series 471, 560, 123, 150, 151, 162, 163, 363, 810, 242 is equipped by appropriate technology (manufacturers UniControls, RADOM, T-CZ) for data transfer and integrated into the RWCN
- Tested possibility to integrate with GPRS service of GSM-R network
- Tested integration of WiFi access points (train depot station Praha-jih) for mobile users

Near future

- Integration of other public networks into RWCN
- Development of the Network Selector and the Session Manager functionalities on terminals
- Implementation of personal units (1600 pcs.) (e.g. portable personal cash registers) a their name addressing

Conclusion

- Three existing communication solutions has been integrated into a single concept at the beginning of the project RWCN in 2008.
- The main benefit of the RWCN is that applications developers do not need to build up and operate their own communication solution and they can use and share the RWCN concept – it enables to run entire communication solutions at reasonable cost.
- Implemented concept of the national communication solution known as the Railway Wireless Communication Network (RWCN) is based on the basic principles of the ICOM architecture described in the InteGRail project.
- We are waiting for new upcoming standards IEC61375-2-6 from IEC/TC9/WG43WG43_SGT_5 Board-Ground Communication.

Thank you for your attention

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