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# The Info-Communication System Requirements of the Deployable Rapid Diagnostic Laboratory Support "Sampling Group" II.

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*The purpose of the authors of this article is to present the information connection system of a sampling group which supports the professional activity of a deployable rapid diagnostic laboratory. Considering the above, the authors of the article investigate the applicable technologies, the possible technical devices and give suggestions for the implementation. This article follows the article published in AARMS. [1] The article is made with the support of project TGYDGL09 "Deployable Rapid Diagnostic Laboratory".*

**Keywords:** *biological laboratory; communication system; land warrior; communication network*

## Introduction

The basic skills and requirements of the info-communication sub-system of the sampling group and its information connection system have been presented in the first part of our article. Subsequently, a possible solution of the external communication of the group (laboratory-sampling group relation) has been presented. Continuing the research, in this article we examine the abilities and the possible solutions of the internal communication of the group.

The internal communication contact of the activity of the laboratory supporting sampling group is one of the subfields of the mobile, deployable biological laboratory. The sampling group installs in a specified, designated area and executes the sampling procedure. The process is controlled by a leader who has to be in continuous communication connection with the sampler or samplers during the sampling procedure.

Accordingly, the channel (link) which can be used in different terrain conditions provides appropriate communication support. The task can be executed in open terrain or in terrain with objects, between buildings or in buildings, so we have to choose a transfer technique or technology which can be used in such varied conditions.

The connection realizes a continuous voice communication in order for the communication of the instructions and a one-way video communication for the implementation of the monitoring of the activity. In order to do more precise task execution – which can be analysed later – it is necessary to provide the video and voice recording and to take pictures of the sampling process.

In view of these needs it is necessary to implement a system which is able to build up a complex wireless communication link to ensure a fast and reliable connection in variable

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terrain conditions with voice and video signal transmission. It is important to have reserves, therefore the transmission of short text messages can also be used to support the tasks.

Based on the requirements the communication link must be able to:

- bridge small and medium distances;
- establish voice and data connection (video, still image);
- fast installation and connection;
- reliable transmission of information;
- appropriate permeability. [1]

## Basics of the Internal Communication of the Sampling Group

The internal communication of the sampling group has to be established as previously described. The group begins to carry out its duties, the process of sampling after the deployment to the specified area. Then they divide into two groups.

One part (the leader) manages the activity from the deployed area. This person has to be in continuous connection with those who carry out the other sub-tasks, the actual sampling activity. The professional management of the sampling group needs an online connection which is able to establish a connection in all terrain conditions. Besides the open terrain, it has to be able to maintain the communication between buildings, possibly from buildings depending on where the sampling is done.

The sampling process can take several hours (Approx. 6–8 hours) which can affect the future task performing of the group. After arriving the biological assets are installed and the samplers prepare for the sampling. Besides the protective and sampling equipment, it is necessary to provide the appropriate communication tools which are able to meet the communication needs described so far. [2]

Therefore, as previously listed, we need a way of connection which provides the appropriate voice, image and video transmission but – compared to the direction of the "external" bio-laboratory – a significantly smaller distance must be provided in this case.

The simplest communication solution is the radio communication link. Its great advantage is its fast connection, suitable for voice connection and possible data connection between various terrain conditions. It can be realized as described above. In addition, the radio voice connection is the most appropriate way to establish voice communication. For the transmission of images and moving images it is necessary to apply a technology which is able to reach a higher speed. The solution can be an IEEE 802.11 standard (Wi-Fi) technology which operates in 2.4 GHz; 3.7 GHz; 5 GHz range and which can be suitable for data communication by taking the effective range into account (see on Picture 1.). The technologies which operate in two different frequency ranges can complement each other without any interference in the system.

v • d • e **802.11 network standards**

| 802.11 protocol | Release[5] | Freq. (GHz) | Bandwidth (MHz) | Data rate per stream (Mbit/s)[6] | Allowable MIMO streams | Modulation | Approximate indoor range[citation needed] | | Approximate outdoor range[citation needed] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | (m) | (ft) | (m) | (ft) |
| — | Jun 1997 | 2.4 | 20 | 1, 2 | 1 | DSSS, FHSS | 20 | 66 | 100 | 330 |
| a | Sep 1999 | 5 | 20 | 6, 9, 12, 18, 24, 36, 48, 54 | 1 | OFDM | 35 | 115 | 120 | 390 |
| | | 3.7[A] | | | | | — | — | 5,000 | 16,000[A] |
| b | Sep 1999 | 2.4 | 20 | 5.5, 11 | 1 | DSSS | 38 | 125 | 140 | 460 |
| g | Jun 2003 | 2.4 | 20 | 6, 9, 12, 18, 24, 36, 48, 54 | 1 | OFDM, DSSS | 38 | 125 | 140 | 460 |
| n | Oct 2009 | 2.4/5 | 20 | 7.2, 14.4, 21.7, 28.9, 43.3, 57.8, 65, 72.2[B] | 4 | OFDM | 70 | 230 | 250 | 820[7] |
| | | | 40 | 15, 30, 45, 60, 90, 120, 135, 150[B] | | | 70 | 230 | 250 | 820[7] |

- **A1 A2** IEEE 802.11y-2008 extended operation of 802.11a to the licensed 3.7 GHz band. Increased power limits allow a range up to 5,000 m. As of 2009, it is only being licensed in the United States by the FCC.
- **B1 B2** Assumes short guard interval (SGI) enabled, otherwise reduce each data rate by 10%.

*Picture 1. IEEE 802.11 Network standards. [3]*

To achieve this, the carrier vehicle of the sampling group must be equipped with the right tools which should be installed after the arrival. For a more precise and efficient connection, the sector antennas should be placed in the right direction to ensure the optimum connection with the samplers. Then the leader can manage the sampling through the established connection. The achieved connection works on a similar principle to the connection system of the "digital soldier – land warrior".

The digital soldier is the best-equipped soldier of the battlefield who connects to the theatre of war with computers, wireless communication and by using GPS. The personal communication system provides the ability to perform all the tasks with the appropriate support such as the digital map, picture and voice commands, messaging options. [4] In order to achieve the above mentioned, they have to possess complex information technology and a communication system which allows the detection, the communication and the integration to the digital battlefield. One part of the equipment is the *helmet sub-system*, which includes a computer interface which ensures the map display and the images of the cameras placed on weapons through a mini-display. As a sub-part of it, the microphones and the earphones allow voice communication. The second sub-part is a *control unit*, which provides the changing of the display image, the radio is manageable with it, and it also allows the transmission of data. The *weapon sub-system* consists of several components. Besides the firearm, its component is the laser distance meter which helps to determine the distance of enemies and other landmarks. The thermal camera provides overnight image, the digital camera sends continuous pictures to the soldier. The data of the distance meter, the camera and the thermal camera are transmitted to the leader (superior) with the help of the control sub-system which is the next sub-system. The *control sub-system* includes the control unit for the video image of the weapon and the multi-functional radio device.


*Picture 2. Complex control and communication system of land warrior. [5]*

Similar to the theoretical structure of the presented (possible) digital soldier, the info-communication equipment of the samplers can be constructed to achieve continuous connection with the governing member of the sampling unit. With the help of the resulting system after the deployment and the starting of the sampling process, the governing person is in a continuous connection with the samplers, can coordinate their work, gives them instructions and gets a complete picture of the progress of the activity to ensure a successful operation. [6]

Based on the analysed and examined technologies and procedures, it is important to elaborate and define the system of requirements for a specific type of device. Accordingly, the next chapter presents the internal and external communication connections of the sampling group.

In summary, it can be seen that voice and data communication are particularly important for the sampling group which – due to the convergence – appears as a basic requirement in several areas of communication nowadays. In order to successfully perform the task it is necessary to ensure sufficient amount of information, so that the activity will be carried out at a proper level without reducing its effectiveness. It is also needed to provide sufficient information for the leaders and thus to be able to give back up with appropriate information.

## The Implementation of the Communication of the Sampling Group in a Possible Version

After the installation the sampling group executes the collection of hazardous samples as defined. The system which provides a complex voice and data exchange is used as communication support. With the application of technologies and technical tools – based on the requirements and capabilities – the emerging needs of services can be completed.

The forwarding of two-way voice and one-way (toward the leader) images between the professional leader of the group and the samplers are a requirement. Its complement can be the exchange of short text messages which can be used as a duplication of a two-way voice-connection. The antenna installed on the central side (deployment area) makes it possible to establish a Wi-Fi connection within the coverage area. This contact provides a two-way connection which enables the system to exchange files and to run an IP-based chat program for a text on-line connection. In addition, if a "smartphone" is handed over to the samplers, the documents and pictures taken with it can be transmitted as well. This, of course, has significance as a complementary function, as a secondary connection.

The above described complex system can only provide the voice-, image- and moving image-based connection. In our opinion, a short-extends communication system like this is composed of several complementary layers.

The first layer is the *subsystem of terminal equipment*. The terminal equipment allows the visual recording of information and different forms of data inclusion. These include the camera, monitor, speakers, sensor, possibly data entry facilitating devices. It is important that the selected terminal equipment support the needs and that the forwarding information should be available in good quality.

The second layer is the *application layer* which – similar to the upper layer of the ISO-OSI model – carries out the management of upper-level protocols, presentation, encoding and control of dialogs. This system includes a variety of applications.

The *layer of services* determines what services the system can provide to the users with the help of the terminal equipment and the communication systems for example the web-service, cooperation, moving image display and transmission of text messages.

The elements of the *connection layer* (communication layer) are the communication tools and accessories of the system. The radios, antennas, satellite equipment effectuate the exchange of data and information. The communication tools always have to meet the needs of the users such as the form, the speed and the security of the information exchange and the quality and the quantity of data.

The last layer is the *standards and procedures layer* which includes the procedures and methods of the operation of the entire system. It guarantees the possibility of linking the several elements and the interoperability between them.

Considering all these, the elements of the complex system serving the internal communication of samplers are:

- Operator workstation (Sampling Leader):
  - micro server;
  - radio system;
  - visual surface;

  - video server;
  - antenna kit.
- Personal sampling equipment:
  - camera;
  - radio;
  - audio unit;
  - power supply;
  - antenna.

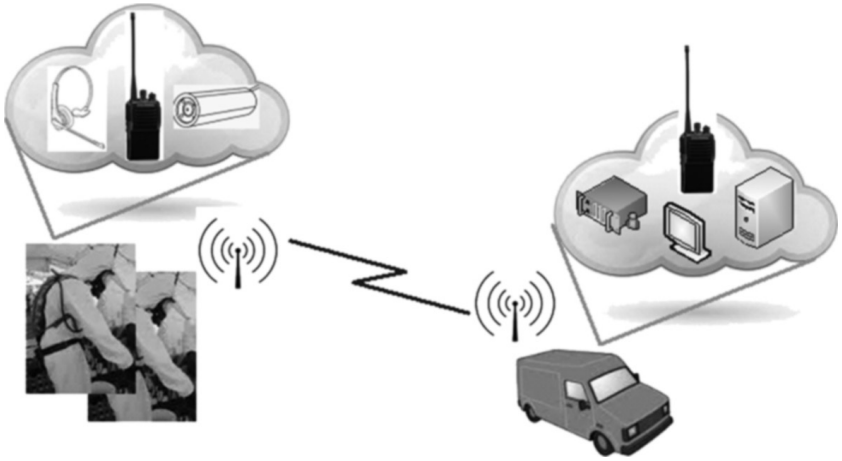

*Figure 1. The sampling groups inner communication (between the main chief and the samplers). [Source: own]*

The wireless technology provides the connection between the two endpoints. The antenna installed in the "operator" side can be – in terms of its type – a sector radiating or a circle radiating antenna which depends in each case on the location of the operation. The sampling activity can be supported and the efficiency of task performing can be increased with the appropriately chosen technology.

The system is able to establish a communication channel and to transmit the data as above mentioned. The complex structure of the system allows the connection.

## *The Sub-Units Providing Two-Way Voice and Video Connection*

The most important element of the system is the VTQ ORCA radio system through which a one-way video and a two-way voice transmission can be realized. In addition, short text messages can be sent between the stations in the 9.6 kbps speed serial channel.

The receiving unit is an excellent complement of the transmission of the video sign. This tool was developed primarily for the media and the television and therefore it forms a perfect unit for the establishment of the continuous voice and moving image connection. The great adventure of the system is that it provides high image quality also at low signal levels. The formation of the tool is suitable for stable installation (in rack cabinet) and also can be placed in motor vehicles.

The main feature of the unit:

- 230–400 MHz frequency;
- COFDM (Coded Orthogonal Frequency Division Multiplexing ) modulation;
- H.264 compression;
- low (40 ms) time delay;
- built-in audio capability;
- easy handling OSD menu;
- 19” formation (standard);
- video antenna interface;
- mono audio output;
- two-way transmission of voice communication;
- two-way RS232 connecting interface for camera control;
- AES (Advanced Encryption Standard) (256Bit) or 3DES (Triple Data Encryption Algorithm) (168Bit) encryption.

The VTQ unit must be connected to a projector unit, a monitor, through which the leader can manage the sampling and continuously follow the activity.

Another element of the system is the micro server which connects to the VTQ unit. The server provides the digital processing of the signals. The incoming signal comes from the camera via a radio system to the VTQ. It goes through on a video digitizer unit where the video image can be displayed with the help of a web browser.

The importance of the server is that the moving image can be recorded by it in digital form (mpeg4) which is made during the sampling and the images can be made in .jpeg format as well. Another big advantage of the server is that these recordings can be transmitted on Ethernet interface and on-line moving images also can be transferred. The “Alvarion” Ethernet microwave antenna, or another, for example the VSAT (Very Small Aperture Terminal) antenna, can be used. Thus, the process of sampling can be followed not only by the leader of the activity but by the leader of the bio-laboratory or by the central leadership.

The other station of the system is the system of the units fitted to the sampler. The sampler establishes a connection with the operator with the help of a vest, a camera and a headset fitted to the protective clothes. The vest includes the transmitter unit for the transmission of the video signal and the transceiver unit for the voice transmission. A battery is placed in the vest for powering it with a capacity for 2–3 hours in continuous use. These devices provide a comfortable fit for the sampler without inhibiting the process of sampling.

The unit sends baseband CVBS PAL (Colour, Video, Blanking, and Sync Phase Alternating Line) video and voice signals for the central unit via the VTQ ORCA COFDM video and audio transmitter (receiver). The signals are transmitted/ received through the antennas fitted in the vest.

A further ability of the system is the transmitting of text messages and providing an online chat via the radio surface. It can be implemented by a hand-mounted keypad or a smartphone device which can be an appropriate backup connection between the sampler and the leader. If the distance allows, a Wi-Fi connection can also be formed but only at 2–300 meters distances with 802.11 technologies. The distance can be increased using WiMAX technology or with the application of steerable antenna. Of course the functions of the text messages can have increased significance when voice based communication is not possible. The radio unit of the system can be operated by circle antenna, the Wi-Fi unit by circle and sector radiating antenna.

## Conclusion

The first step of the task of the deployable rapid-diagnostic laboratory is sampling. After the deployment of the laboratory the sampling process must be initiated this is a long and complex process and needs professional support.

The samplers collect the samples from the specified field stage or contaminated area. The samples are sent to the bio-laboratory where the analysis is carried out. The biological test are easier if they have more information. This information has to be transmitted via the communication system of the bio-laboratory.

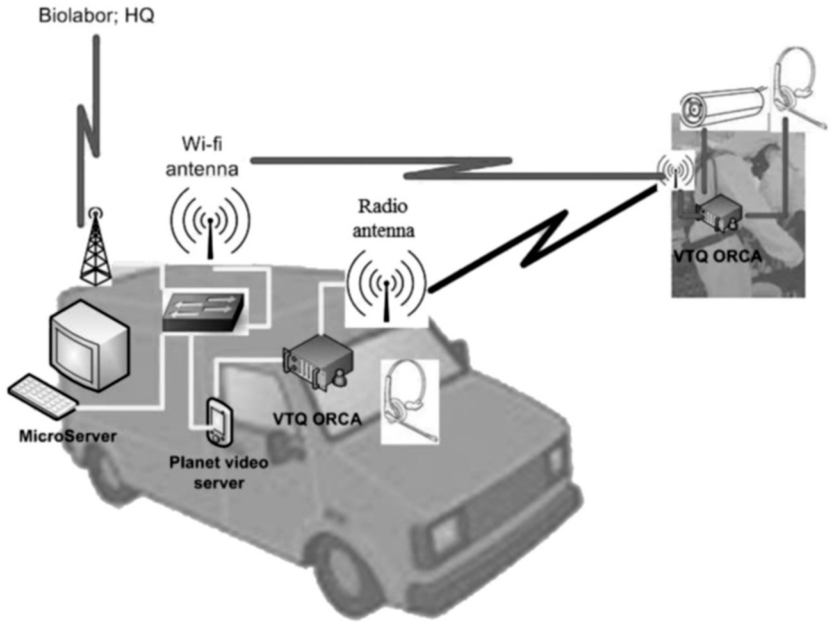


*Figure 2. The complex communication and information system. [Source: own]*

In terms of the information connection of the sampling group it defines two main directions. One is contact maintaining with the bio-laboratory, the other is the connection in the group. The process of the group's activity can be supported with the above described system principles. The established complex info-communication system is able to transmit voice and data and capable of supporting the sampling procedure which is the basic element of the successful task execution. It is important to highlight that the data transmission for the bio-laboratory or possibly for the higher level of management can be realized with this system. With the continuous development of the professional field and with the appearance of the new needs the system requires further development. This should certainly be taken into account in the planning of the system. The used technical tools and technology could be developed according to the needs.

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