

**JÁNOS CSENGERI<sup>1</sup>****Remote Towers I.<sup>2</sup>****Távoli toronyirányítás I.****Abstract**

*In the present article the author demonstrates the basic elements related to remote towers, such as the remote control, its development, types and logic. The concept and content of remote sensing is being determined and also its relation to the core topic will be demonstrated. The possible services of the remote tower and the area of responsibility will be identified. In the last chapter a review of atypical air traffic control tower solutions is presented also mentioning the remote, virtual air traffic control.*

*Keywords: remote control, remote sensing, ATC tower, remote tower, controller, controlled*

**Absztrakt**

*A szerző a publikációban bemutatja a távoli repülőtéri toronyirányításhoz kötődő alapfogalmakat úgy, mint a távirányítást, ennek fejlődését, fajtáit és logikáját. Meghatározásra kerül a távérzékelés fogalma és tartalma, illetve kapcsolódása a fő témához. Megtörténik a lehetséges távoli repülőtéri irányító torony szolgáltatások és felelősségi terület beazonosítása. Utolsó fejezetként az atipikus repülőtéri irányítótorony megoldások ismertetése történik, benne a távoli, virtuális repülőtéri irányítótoronyal.*

*Kulcsszavak: távirányítás, távoli érzékelés, repülőtéri irányítótorony, távoli repülőtéri irányítótorony, irányító, irányított*

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<sup>2</sup> The work was created in commission of the National University of Public Service under the priority project KÖFOP-2.1.2-VEKOP-15-2016-00001 titled „Public Service Development Establishing Good Governance” in the Gyözö Concha Doctoral Program.

## INTRODUCTION

It is the remote air traffic control that seems to become the main direction in air traffic management service sector in the following years that determines the ruling interest in the field of this profession, providing a great possibility of development and innovation. The air traffic control as a type of service, and the military air traffic control in the framework of defence public service are facing such a widespread use of technology that represents significant added value nowadays. In the series of my 3-item articles I am going to expound this kind of technology, namely the remote tower (r-TWR) control and its related topics.

In the first part I demonstrate the development of remote control technics and its fields of utilization, and I also touch upon the topic of remote sensing. I am to specifically emphasize the development and spread of remote tower control in the field of services and technology, and also its capabilities and opportunities.

In the second part of the series I examine the possibilities of implementation of remote air traffic control services at the national airports, containing the military airfields as well. I demonstrate the added values of remote tower control specially emphasizing the military section. Focusing on the future opportunities, I suggest some solutions for the progress of the system or technology.

In the third part of this research I examine the possible utilization of the technology in practice. Consulting experts, I analyze the general organizational architecture applied so far, and demonstrate the set-up of the air traffic control center (in a general outline). As the widespread use of this technology is „round the corner”, it is essential to search its possible implementation in air traffic controller training, which is also a task of this phase.

## REMOTE CONTROL

The comfort and „handyness” of remote control seems to be such an old wish of humans as flying or rapid travelling. Operating from a distance can be caught in such occult (and up to the present not proven) phenomena surrounded by legends and myths, as for example telekinesis, that is moving objects from a distance with the help of the mind. However, influencing systems with the help of messages (orders) can be interpreted as remote control, too, just as it happened in ancient Rome, where couriers sent by the capital conveyed the orders concerning (affecting) the provinces.

The substance of remote control could be confirmed by several other examples, but it may even more embarrass the picture. In the absence of exact definition, remote control can be determined as it follows: affecting an object or living being or their system by an operator (that can be a person, organization, another object, electronic algorithm etc.) who is not present, and the affected being gives the corresponding action to the operator's order, adequate to its want.

Air traffic control at the airports happens in a direct way which means the controller can see the aircrafts, or data of various devices may help his duty. Controllers and those under

control (participants of air traffic and the ones running on the area of the airport) are settled close to each other. Though the instructions are transmitted with the help of devices (radio equipment, radio frequency, perhaps light signals) these signals are not coming directly from the operator and not perceived by the operated being's senses. Moreover, the affection is carried out by methods directed at the concerned ones by the system, which in this case includes both the controller and the controlled ones, and those accept the influence complying with, and making others comply with the given rules. In this case, the operated beings firmly need the action of the operator, so this relation is not to be confused with political pressure and will-exercising.

To understand the direct control of airports, we may think about infrastructural or industrial examples, too. In a nuclear power plant the systems are operated not directly, but from a control room that is situated together with the reactor, but in a distance from it. In the factories, robots making up cars are influenced by computer programmes for more effective work, not directly, but from a short distance, and the result can be observed and measured locally.

Remote control in case of airports should be understood in a way where the controller is moved away from the controlled in the physical space, and it detects the situation of aircrafts indirectly, through electronic devices, cameras, monitors for example. (Figure 1.)

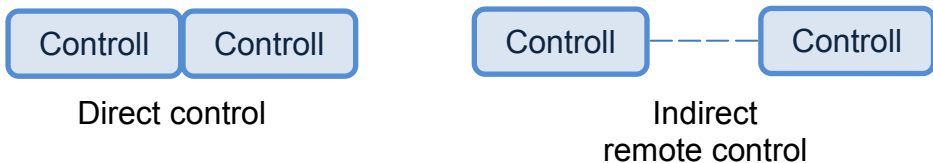


Figure 1.: The direct and the indirect remote control.

Source: edited by the author

Should we find analogies for the above seen figure, we'd better think of our everyday objects of use. We control our television directly when we operate it with the buttons on the TV set. It is the same case when we open the car door with the help of the key, with turning it in the lock. We can operate the air conditioning with the buttons on it as well, moreover children can direct their cars by hand. But all of these devices and objects are provided with remote controlling, which makes their use more comfortable, flexible and more enjoyable. Certainly, the list of similar devices is much longer, perhaps it is endless.

Devices are provided with various remote control technologies, such as the use of infra red light<sup>3</sup> or radio signals<sup>4</sup>, bluetooth contact<sup>5</sup>, but it is possible to control with movement,

<sup>3</sup> Lakásvezérlés távolról IV.; <https://www.villanylap.hu/lapszamok/2013/julius-augusztus/2462-lakasvezerles-tavolrol-iv>; downloaded on 20.06.2017.

gestures<sup>6</sup>, or eye-movement, too; what's more, devices, objects (even artificial limbs)<sup>7</sup> can be directed with the help of electro-magnetic waves of the human brain. In air traffic control, in case of sound or radio error, intervention happens with light, or with processes determined and exercised in advance. Moreover, it is not the devices that are under control, but people who pilot the aircraft. In case of unmanned aircrafts, it is the pilot on the ground, taking the operator's workstation who gets the relevant instructions and not the aircraft itself (whether the above mentioned pilot works with remote controlling or not is not significant, it is just curiosity).

However, not only single devices can be remotely controlled, but whole systems as well. It is enough to mention our everyday surrounding, where remote controlled apartments are becoming more and more popular. The remote controlling of air traffic services is the same case, but with a much more difficult construction. Safe traffic must be provided in air, between the airplanes in the scope of the responsibility of the tower controller, and those arriving from a distance entering this area, and also between the vehicles and planes running on the ground; at the same time entering the runway without permission must be arrested etc. The bundle of services of the tower control may be placed in a distance from the airport, because the air traffic controllers do not control the traffic with direct signs (e.g.: visual or sound), but, as it was mentioned before, with the help of transmitting devices or medium. Even the subordinate (e.g.: fire-fighters, ambulance, maintenance service) or co-ordinate (meteorology, air reporting office) services aren't contacted directly, but through radio or telephone contact. And these channels of communication are easy to expand to longer distances.

### REMOTE SENSING

It is the high-definition camera system, one element of the infrastructure enabling remote tower control, that allows gaining live motion picture of events taking place at the airport and its airspace. As a supplement to this, various radar technologies are applied both for tracking in-air and on-ground transport (later on these will be detailed).

The way of sensing not personally by the senses or by gaining data with local measuring, is called remote sensing. An explanation is mainly given by the law of survey and cartography: *"remote sensing: procedures for gaining data in a way where data are provided without establishing direct, physical contact with the examined object"*. Sándor

<sup>4</sup> Early Developments in Remote-Control, 1901.;

[http://ethw.org/Milestones:Early\\_Developments\\_in\\_Remote-Control,\\_1901;](http://ethw.org/Milestones:Early_Developments_in_Remote-Control,_1901;) downloaded: 2017.06.20.

<sup>5</sup> Bluetooth – How it works?; <https://www.bluetooth.com/what-is-bluetooth-technology/how-it-works;> downloaded on 20.06.2017.

<sup>6</sup> Távirányítás gesztusokkal, Wi-Fi segítségével; [https://www.hsw.hu/hirek/50389/wisee-wi-fi-taviranyito-KINECT-GESZTUS.HTML;](https://www.hsw.hu/hirek/50389/wisee-wi-fi-taviranyito-KINECT-GESZTUS.HTML) downloaded ON 20.06.2017.

<sup>7</sup> CNET News - Brainwave tech could help ALS patients control appliances; [https://www.youtube.com/watch?v=sHONFO5h2hg;](https://www.youtube.com/watch?v=sHONFO5h2hg) downloade on 20.06.2017.

Jombach collected 21 further definitions in his PhD thesis. Reading the definitions one after the other, we find that each describes the collection of data which happens from a distance, but here and there we meet some embarrassing details, as for example: „*aquisition of information about the state and condition of an object*” or “*we can gain more information that may not be perceived by our senses directly*” and „*it is a technique used to derive information about the physical, chemical, and biological properties of objects without direct contact.*”<sup>8</sup>

On the basis of the above, it is becoming clear that remote sensing is not simply a rough fact-finding, but rather precise, detailed measurement of a wide spectrum of characteristics. Again, we may refer to the above mentioned law: „*collection of data capable of carrying out ground, air or space remote sensing measurement, serving the purpose of making maps, aiming to gain geodetic, cartographic, geophysic, geologic and navigational data as a result.*”<sup>9</sup>. As it is shown, the goal of remote sensing is to carry out precise measurements, which points beyond its application in the field of air traffic control.

With all of this I do not intend to disparage the profession of air traffic control (me myself have the same qualification, too), what I try to highlight is that control carried out by people is considering rough database, contrary to precise database. As an example: in air, separation between aircrafts can be measured in miles, where some ten meters do not count as significant distance, what’s more, controllers work as a rule with margins, that is they add a little to the minimum values. In a period, when air traffic control becomes a totally robotized, automated service the preciseness of data is likely to be utilized to a greater extent (in order to utilize the capabilities of air space to a greater extent, the margin values are being minimized), although sensor systems even today are capable of accurate data presentation.

Evidently, both remote controlling and remote sensing can be defined in a special way in case of r-TWR, logically we may not skip the interpretation of these expressions, that are mostly linked to the topic of remote towers. Instead of remote controlling, we could speak about intervention from a distance into the „air concerned side” of the airport, while remote sensing is to be defined as using precise data collected from a distance, with restriction in preciseness. Both fields are concerned, but not in their classical definition.

#### POSSIBLE REMOTE TOWER SERVICES

First of all, we must see clearly how much of the airport processes belong to the responsibility of the r-TWR, that is, what kind of services it ensures and how big is its responsibility in these fields. Let me touch upon the infrastructural issues later.

<sup>8</sup> i.m. LONGLEY et al. 2011, szabad fordítás

<sup>9</sup> 2012. évi XLVI. törvény a földmérési és térképészeti tevékenységről I./1./1. §/9.

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To begin with, let's see the kind of services and the ones that ensure them in r-TWR-s. When listing air traffic services, we meet quite a long list of them. What's more, services present at the airport make an even longer range of varieties.

Considering air traffic services, we may find the following:<sup>10</sup>: there is air traffic control service (area control service, approach controller service, aerodrome controller service), air traffic advisory service, aerodrome flight information service, alerting service. Workflow between them is demonstrated by the figure below (Figure 2). Responsibility area of services taking place in the remote tower is marked with blue, while that of apron control service is marked with green. Both areas might as well be served from a remote tower.

To ensure the safe and effective operation at the airport, several other services are set up and employed, just as aeronautical information service – AIS,<sup>11</sup> apron control,<sup>12</sup> aerodrome coordination, aviation meteorological, fire-fighter, ambulance, first aid, aviation medical, technical rescue, police, flight protection, public health services etc.<sup>13</sup>

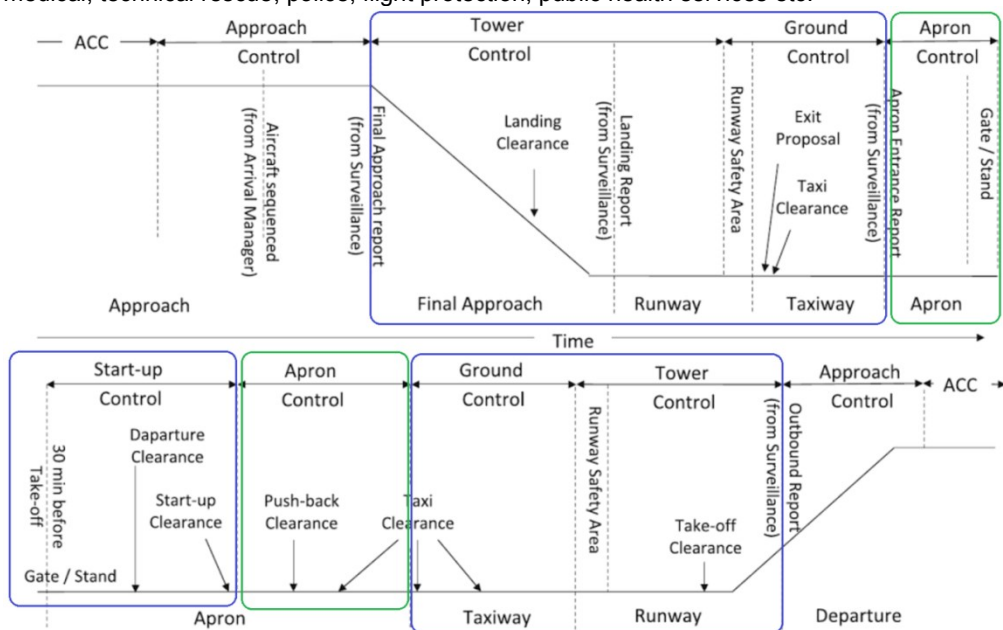


Figure 2.: Workflow schematic of the airport traffic control [separated in arrival- (top) and departure traffic (bottom)].

Source: Norbert FÜRSTENAU (edited): *Virtual and Remote Control Tower*, p.4.

<sup>10</sup> 57/2016. (XII.22.) NFM rendelet. Második rész/I. fejezet/2./5. §/a-d

<sup>11</sup> I.M. ELSŐ RÉSZ/1./3. §/5.

<sup>12</sup> 57/2016. (XII. 22.) NFM RENDELET. ELSŐ RÉSZ/1./3. §/37.

<sup>13</sup> 1995. évi XCVII. törvény a légiközlekedésről. Ötödik rész/ II. Fejezet/50. §

From the first group (air traffic service – air traffic control services) it is the air traffic control that is present at the airport. Its task is to prevent the participants from air traffic crashes, to prevent crashes on ground between aircrafts and obstacles on the manoeuvring area, and to ensure the rapid and systematic flow of air traffic.<sup>14,15</sup> It is quite typical at military airports to ensure approach controller service,<sup>16,17, 18</sup> which is supposed to prevent controlled arriving and departing aircrafts from crashes and to ensure rapid and systematic flow of air traffic.<sup>19, 20</sup>

It is also important to clear up the definition of manoeuvring area, mentioned among the fields of responsibility of the aerodrome controller. As it was mentioned before, aprons are exceptions to the detailed responsibility area, as according to the Hungarian air transportation law: „*aerodrome manoeuvring area is the area created for the purpose of taking off, landing and taxiing of aircrafts with the exception of the aprons.*”<sup>21</sup>

Finally, one more concept is left to be defined in the topic of aerodrome controlling: namely, in which case is it necessary to establish this service? „*In Budapest Flight Information Region it is necessary to ensure aerodrome controlling service at the airport in the meantime of opening hours in the following cases:*

a) *the number of operations carried out by arriving or departing aircrafts working in accordance with VFR exceeds 20,000 on a yearly basis,*

b) *the number of operations carried out by arriving or departing aircrafts working in accordance with IFR and VFR exceeds 12,000 on a yearly basis,*

c) *the number of operations carried out by arriving or departing aircrafts working in accordance with IFR exceeds 6000 on a yearly basis,*

d) *irrespective of yearly number of operations, aircrafts carry out CAT II. or CAT III. precision approach. Inasmuch as the above described conditions are not fulfilled, but the managing body of the airport considers it reasonable, it is possible to provide aerodrome flight information service or aerodrome controller service in the opening hours of the airport.*<sup>22</sup> In the above quotation „*Budapest Flight Information Region*” might be misleading, but the whole airspace of Hungary is meant by it: „*air space over the area of Hungary delimited by its state borders, where air traffic service is provided up to the altitude of FL660 (20,100 metres)*”(Budapest Flight Information Region).<sup>23</sup>

<sup>14</sup> 57/2016. (XII. 22.) NFM rendelet. Második rész/1. Fejezet/2./5. §/ac)

<sup>15</sup> Az Európai Bizottság 923/2012/EU végrehajtási rendelete. 7. Szakasz/SERA.7001./a), b), c)

<sup>16</sup> MILAIP HUNGARY, AD 2-LHKE-7

<sup>17</sup> i.m. AD 2-LHPA-9

<sup>18</sup> i.m. AD 2-LHSN-7

<sup>19</sup> 57/2016. (XII. 22.) NFM rendelet. Második rész/1. Fejezet/2./5. §/ac)

<sup>20</sup> Az Európai Bizottság 923/2012/EU végrehajtási rendelete. 7. Szakasz/SERA.7001./A), b), c)

<sup>21</sup> 1995. Évi XCVII. Törvény a légiközlekedésről. Nyolcadik rész/71. §/22.

<sup>22</sup> 57/2016. (XII. 22.) NFM rendelet. Második rész/1. Fejezet/4./6. §/(2)-(3)

<sup>23</sup> i.m. Első rész/1./3. §/25.

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All the services of the second group (aerodrome services) are situated at the airport itself, the only question is, which of them can be moved to a remote place to ensure its service from a distance.

This type of service is not specifically an aerodrome service, nor an air traffic service. Air reporting service, as it is commonly used, is „the Aeronautical Information Service (AIS) established with the aim of providing the necessary information to ensure the effective, regular and safe way of air traffic.”<sup>24</sup> This bundle of services includes the room for the preparation for flight, maps, air traffic information etc. One of the well-known elements of this service is the so called AIS Reporting Office (ARO), where pilots may hand in their flight schedule, ask for air traffic information, the air traffic controller in charge may issue communication (NOTAM) about the changes in the state of the airport, etc. With making available the proper informational background, this service might as well be employed for the airport air traffic from a distant center (at present, all three military airports operate with such a service, one at each).

The apron control service „controls the operation and movement of aircrafts and other vehicles running on the area of the apron.”<sup>25</sup> As in the course of this movement vehicles are relatively close to each other (probability of crashes is higher, precise standstill and parking is necessary, etc.), direct control is of high importance. Consequently, this kind of service is worth keeping at the airport itself.

Considering airport coordination service, definition described by law is not traceable. The following definition is quoted from the airport regulations of Liszt Ferenc Airport Budapest: „Service provided for the effective utilization of ground services to ensure coordination, safety and capacity utilization of international airports.”<sup>26</sup> This definition shows that the mentioned service is responsible for the effective provision of the so called ground services (such as refueling, cleaning services, baggage management, de-icing etc.), and also for the coordination of these activities. In case of military airports, similar processes are carried out, though it is mostly the commanders of the aviation subunits and those of airport engineering personnel who coordinate the operation and issue commands to make effective implementation. To determine whether this service (as much as it is established at all at the given airport) can be provided from a distance or not is highly influenced by the relationship built up with ground services, which characteristically differ, depending on the airport, and this relationship is well worth examining.

Interviews conducted with the professionals of the meteorological service at Szolnok (Hungary), it becomes clear that providing flight meteorological services from a distance can be a solution, and data of their instruments installed at the airport are to be transmitted

<sup>24</sup> 57/2016. (XII. 22.) NFM rendelet. Első rész/1./3. §/5.

<sup>25</sup> Az Európai Bizottság 139/2014/EU rendelete. 2. cikk/5.

<sup>26</sup> Budapest Liszt Ferenc Nemzetközi Repülőtér Rendje; Meghatározások. azonosító: RR-M, változat: 04., p.M-6/7



in electronic way. The only problematic issue is local perception (visual perception of weather circumstances). At the moment it is unknown whether it is possible to perform this task through camera image in adequate quality (e.g.: differentiate between the types of clouds) or not. However, with the utilization of the remote sensing technology, flight meteorological service most probably could be provided from a distant center for several regional or military airports. To rise further questions and problems, it would be necessary to carry out specific researches in the future.

Fire-fighter, ambulance, first aid, aviation medical, technical rescue, police, flight protection, and public health services are to be provided at the airport itself, as they ensure their services „physically” there. Potentially, some liaison personnel may stay at a remote center, next to the control service to realize effective communication. But we may only find the answers to these questions in a later phase, during the simulation exercises.

By the first, theoretical examination, we find that out of the enumerated services, aerodrome control, apron control, aeronautical information, and flight meteorological services can be provided by the remote tower. It is also to be defined what kind of new services could be established in the future with the help of r-TWR specialities.

Next I intend to define the most important r-TWR service, namely the aerodrome control service. In the last paragraph of the previous chapter I did not mention one definition, namely, the the „air concerned side” of the airport. ICAO (International Civil Aviation Organization) is the organization of the United Nations dealing with aviation, it has 191 member states.<sup>27</sup> Its relevant regulation rates runway and taxiway, aprons, air and ground navigation and traffic control aids as the aviatinal side of the airport.<sup>28 29</sup> (or, in this case, operation, employment, observation and tracing the state of the latter are meant here).

Much as it may seem banal, I think, the previous definitions must be described in detail:

- runway<sup>30</sup>: „it is a square area of an inland airport, built to serve the taking-off and landing of aircrafts”;
- taxiway<sup>31</sup>: „the area of the inland airport assigned for taxiing (riding on ground – editor’s note) of aircrafts and for connecting certain areas of the airport”; including the following:
  - aircraft stand taxiway centerline: part of the apron assigned as taxiway, exclusively for the purpose of approaching the aircraft stands;
  - apron taxiway: part of the taxiway system crossing the apron in order to provide path for crossing the apron;

<sup>27</sup> About ICAO; <https://www.icao.int/about-icao/Pages/default.aspx>; downloaded on 23.06.2017.

<sup>28</sup> Csengeri János: A repülőterek futópálya és gurulót tulajdonságainak bemutatása. p.229.

<sup>29</sup> ICAO Doc 9184 Airport Planning Manual, Part 1 - Master Planning, p.1-(V), 1-(VI)

<sup>30</sup> Az Európai Bizottság 923/2012/EU végrehajtási rendelete, 2. cikk, 113.

<sup>31</sup> I.M., 2. cikk, 126.

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- *rapid exit taxiway: taxiway, adjoining the runway in acute angle, allowing landing aircrafts to leave the runway faster, compared to other taxiways, accordingly minimize the engagement of the runway;*
- apron<sup>32</sup>: „the area assigned for the stay of aircraft in order to permit the passengers' embarking and disembarking, loading and unloading goods and mail, refuelling, parking or maintenance”;
- (airport) air and ground navigation and traffic control aids<sup>33 34</sup>: - it is a collective term which includes:
  - *indicators and markings:*
    - indicators and signalling devices and markers (wind direction indicator, landing directions indicator, signal area and signalling lamp);
    - markings (runway designation marking, runway center line marking, threshold marking, arrows, aiming point marking, touchdown zone marking);
    - service road markings;
    - mandatory instruction markings;
  - *advisory markings;*
  - *lights and lighting systems:*
    - emergency lightening;
    - aeronautical beacons;
    - approach lights (non-precision approach lights, CAT I/II/III precision approach lights);
    - visual approach glidepath indicator systems (T-VASIS és AT-VASIS, PAPI és APAPI);
    - circling guidance lights;
    - runway lights;
    - apron lights;
  - *panels and markers.*

These are the areas and devices the aerodrome controller is responsible for (with the exception of the aprons), gives authorization to the ones acting at the scene, provides information, utilizes airport devices in the appropriate way, pays attention to the state of devices and markings, etc.

<sup>32</sup> I.M., 2. cikk, 42.

<sup>33</sup> Mudra István: Repülőterek és repülőtéri berendezések. Repülésoktatási és Dokumentációs Központ, Budapest, 2007. p.ix-xi

<sup>34</sup> ICAO Doc 9184 Airport Planning Manual, Part 1 - Master Planning, p.1-69, 1-70

## THE REMOTE AIR TRAFFIC CONTROL TECHNOLOGY

Before demonstrating the remote air traffic control technology, I must define the remote air traffic control itself first. Among the types of air traffic services, is not the air traffic control that is at first place where the controller and the controlled are staying in a well-separated distance, or work in a centralized way. On the contrary, it is the last one.

Considering this aspect, it is the area control service among the control services, that we may think of first. In this case, all the civil air traffic taking place in Hungary's high air space (~6 100m – 20 000m) is controlled from a central place in Budapest (33-35. Igló utca, 18. district). The situation of the approach controller of Liszt Ferenc Airport, Budapest is a similar case, because it is also controlled from the above mentioned workspace. The responsibility area of this service is generally extended to 50-90 km – 10-20 km sideways from the airport.<sup>35</sup>

Furthermore, we may refer to the Hungarian Defence Forces Air Command and Control Center, situated in Veszprém, where JAS-39 Gripen swing role aircraft are controlled from, on the occasion of exercise or training flights in a separated airspace, or in case of airspace alert, should it be at any place in the Hungarian airspace.

We have a peculiar case, too, which has been realised by Hungarocontrol Ltd., the Hungarian civil state air traffic service, answering a NATO request, namely the reopening and returning of high airspace of Kosovo which had been operating as no fly zone for 14 years, together with providing its air traffic control service<sup>36</sup>. The peculiarity is that the two countries do not even have common borders, still it is possible to provide the air traffic control (it has been operated since 3rd April, 2014.) for them. From the technical point of view this system requires three pillars: the composite radar information in the region, transfer of communication between the control service of Budapest and the participants of Kosovo air traffic, and a safe way of link to transfer the collected data. As the conditions were successfully met (following a lengthy preparational, cooperational simulation task, and a series of negotiations, and diplomatic actions) the continuous provision of the remote air traffic control has been established.<sup>37</sup>

Controlling traffic running across such a huge area, and perceived by radar stations cannot be interpreted in a way where the controller and the controlled are situated closely to each other. To set a common example: it is as uninterpretable as dividing or multiplying with zero, in mathematics. The core of these types of controlling is centralization. There is no way to collect data by human perception about the aircrafts, that is it is essential to use remote air traffic control technology and, from a practical point of view, to develop work stations at a central place, not in a scattered way.

<sup>35</sup> Norbert Fürstenau (edited): Virtual and Remote Control Tower, p.4.

<sup>36</sup> Pongrácz Gábor: A NATO és Magyarország által megvalósult koszovói légtérnyitás, diplomáciai és gazdasági hatásai. p. 6.

<sup>37</sup> I.M. p.32-36.

However, there is one solution where radar-guided control is realized with the close connection of the controlled ones: this is the so called AWACS (Airborne Warning and Control System) aircraft (such as: E-3 Sentry, E-2 Hawkeye, Saab 340 AEW&C, Embraer E-99, stb.). In this case the sensor, providing data about the air space, is situated on board, the personnel of control is inside the aircraft, while the aircraft itself is the participant of the air traffic.

But the air traffic control service, not working with radar information (they use information for orientation and to inform aircrafts about each other's situation on the basis of their check-in, provide useful advice, but they do not have disposal of commanding or controlling) and the civil air traffic advisory/flight information service, divided to three main territories (East, North, West) also work in a centralized way, at the above mentioned registered office, and they are authorized to operate in the so called uncontrolled airspaces (where there is no control service provided). According to the relevant law, their responsibility is *„providing useful information and advice in order to carry out safe and effective flight.”*<sup>38,39</sup>

#### ATYPICAL AIR TRAFFIC CONTROL TOWER SOLUTIONS

After reviewing the connected topics, in the last chapter of the article I demonstrate the alternative air traffic control tower solutions. As I mentioned in the introduction, I will get till giving an overall picture of the technology in this article, this was what I defined as the goal of research at present. As we could see, in order to avoid logical defects, it was necessary to review several other areas of the subject-matter, too.

In the title of this chapter, I used the expression „atypical”, as I am going to describe solutions that are not widespread or typical, nor these technologies may replace each other. However, using these technologies makes it possible to establish and work airport (air traffic) services appropriate for needs and opportunities emerging from the environmental or human part, in case those differ from the usual ones.

The first such possibility, replacing the traditional r-TWR is provided by the so called Mobile Air Traffic Control (ATC– Tower). Several manufacturers (e.g: Aeronav,<sup>40</sup> BSS,<sup>41</sup> Nucleo,<sup>42</sup> Pol-Mot Rail,<sup>43</sup> Neat Vehicles,<sup>44</sup> Handling Specialty,<sup>45</sup> MobileATC,<sup>46</sup> Leonardo,<sup>47</sup> stb.) offer such solutions (Figure 3.).

<sup>38</sup> 57/2016. (XII. 22.) NFM rendelet. Második rész/l. fejezet/2./5. §/b), c)

<sup>39</sup> Az Európai bizottság 923/2012/EU végrehajtási rendelete. 7. szakasz/SERA.7001./d)

<sup>40</sup> Aeronav, Mobile and Transportable ATC Tower; <http://www.aeronavgroup.com/wp-content/uploads/2013/01/l-Mobile.pdf>; downloaded on 29.06.2017.

<sup>41</sup> BSS, Mobile Air Traffic Control Tower; <http://www.bssholland.com/product/mobile-air-traffic-control-tower/>; downloaded on 29.06.2017.

<sup>42</sup> Nucleo, Mobile Air Traffic Control Tower;

<http://www.nucleocc.com/img/uploads/20170522120541.PDF>; downloaded on 29.06.2017.

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Figure 3.: Mobil air traffic control tower solutions (from top, left to right products of Aeronav, BSS, Nucleo, Pol-Mot Rail, Neat Vehicles, Handling Specialty, MobileATC, Leonardo).

Source: edited by the author, pictures from webpages referred above

In order to avoid misinterpretation, I had to mention these solutions provided by manufacturers, but they have little to do with remote tower control. As the manufacturers put it in their product fiche, and as Tímea Vas summarizes it,<sup>48</sup> these control towers are provided with regular working stations, and they can be employed anywhere. They can be utilized and employed as reserve work station for emergency, on operational area, in case of initial or long-range operation of new-established airports, in situations of disaster relief tasks, on airports with poor infrastructure, in case of located duties, as a supplementary device to traditional remote towers etc.

As its name suggests, the greatest advantage of this solution is that it is mobile, movable. By this characteristic, it provides an appropriately flexible solution both for a civil air navigational service, and the defence forces, too. Furthermore, considering the many

<sup>43</sup> Pol-Mot Rail, Mobile Air Traffic Control Tower; [http://www.polmotrail.pl/pdf/m\\_atc\\_en..pdf](http://www.polmotrail.pl/pdf/m_atc_en..pdf); downloaded ON 29.06.2017.

<sup>44</sup> Neat Vehicles, Mobile Air Traffic Control Tower; <http://www.neatvehicles.com/mobile-air-traffic-control-tower/>; downloaded ON 29.06.2017.

<sup>45</sup> Handling Specialty, Mobile Air Traffic Control Tower for Defence Industry; <http://www.handling.com/all-solutions/custom-scissor-lift-mobile-control-tower/>; DOWNLOADED ON 29.06.2017.

<sup>46</sup> MobileATC, Product and Services; <http://www.mobileatc.com/products-services>; downloaded on 29.06.2017.

<sup>47</sup> Leonardo, Aerodrome Flight Information System; <http://www.leonardocompany.com/en/-/afis-2>; downloaded on 29.06.2017.

<sup>48</sup> Tímea Vas: The remote and mobile air traffic control tower and its possible application to the operational area. p.148-150.

sectors of public service (healthcare, police, disaster relief, home defence) also possessing aircrafts, it is a possible solution to share a common state contingent in extreme situations.

To replace the traditional remote control tower there is another solution, namely the virtual remote air traffic control tower (Figure 4.).

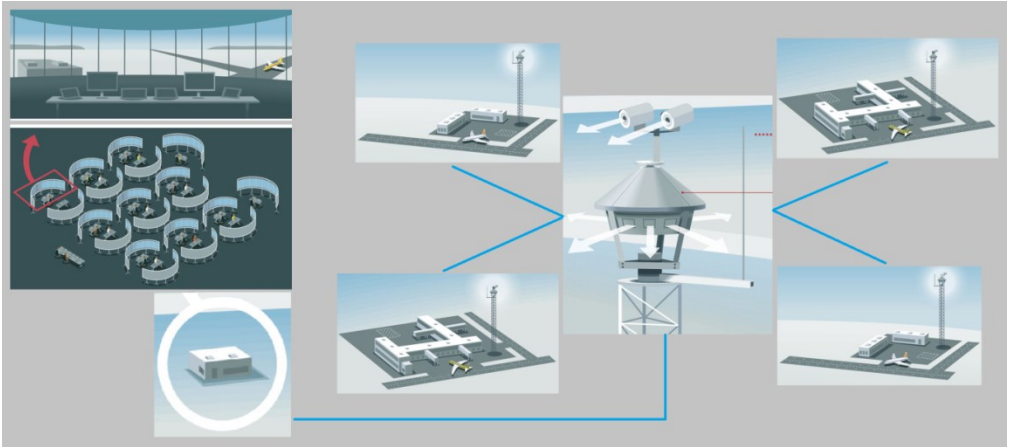


Figure 4.: Schematic image of remote air traffic control tower with airports, cameras, data links, control center and workstations.

Source: edited by the author; <http://saabgroup.com/Media/stories/stories-listing/2015-12/how-does-a-remote-tower-system-work/>; downloaded: 03.07.2017.

Remote air traffic control may ensure that airports are run cost-effectively (and with other benefits) whilst maintaining safety. As we can read on the website of Avinor, a well experienced airport operator in Norway, airport costs might be reduced by 30-40 percent by operating air traffic services for several airports from one working position.<sup>49</sup>

Remote air traffic control is based on several integrated and interacting subsystems. High resolution images and other information are sent from the camera tower at the airport to a workstation in the remote control tower. This may contain several of workstations where an air traffic controller can monitor two or three airports in parallel.

The air traffic controller can monitor air-traffic via screens which provide an image that corresponds to the view through the window in a traditional control tower. The remote control tower is also connected to all the local systems that are necessary for air navigation services such as controlling runway lights, collecting local weather data, controlling

<sup>49</sup> Avinor, Our services, Remote Towers; <https://avinor.no/en/avinor-air-navigations-services/services/remote-towers/>; downloaded on 03.07.2017.

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emergency alarms and handling navigation support. The camera tower also contains a signal lamp which could be used as a back-up in the event of a radio communication failure between the air traffic controller and the pilot. The system can also be used to serve as a reserve control tower for large airports.

The remote control tower may contain several workstations for remote air traffic control. At each workstation, the controller can monitor air traffic via the screens. The remote control tower is also connected to the necessary local systems such as runway lights, weather data, emergency alarms etc.

The camera tower provides high-resolution images and other necessary information which are sent from the airport to the air traffic controllers in the remote control tower.

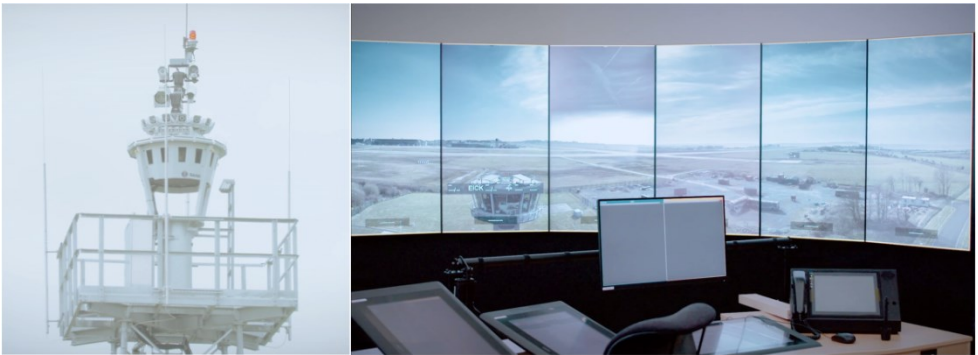


Figure 5.: Main elements of a remote tower.

Source: screencuts from the commercial film of IAA (Irish Aviation Authority); <https://www.iaa.ie/air-traffic-management/innovation/remote-towers>; downloaded on: 03.07.2017.

## SUMMARY

Ideological content of r-TWR technology is the following: each air traffic or aerodrome service not required to get in direct physical contact with the traffic of the airport, and in case of which the access to necessary information is achievable, should be exported to a remote, and perhaps centralized station.

This solution is resembling the phenomenon, known as outsourcing in the business, but here it is not needed to contract a provider, because the organization being in charge may carry out such innovation/reorganization considering rationalization. But we may rely on more specific examples:

- application of the technology is reasonable inside state borders if several remote control towers of military or regional airports are replacable by a control center;
- in case of a busy international airport such a decision may be reasonable, if the added value of the technology significantly improves the safety and efficiency of air

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traffic, and improves security of system operation, etc. (in case of Liszt Ferenc International Airport Budapest and Hungarocontrol Ltd. implementation of the technology possesses demonstrational characteristic as well – as Hungarocontrol Ltd. should prove achievability as a pathfinder of the technology);

- from the operational point of view the control unit can carry out its tasks from a blockhouse, or in certain cases there is no need to be present at the operational area at all.

Defining the „transferable” services has a great importance from operational angle, because by providing remote services individual safety could be improved a lot.

In the following article the remote control tower itself, and the advantages of its utilization will be highlighted.

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