This deliverable provides a detailed overview of experiment design and plan for the CAR Venue. This document provides EXPERIMEDIA integrators and evaluators all necessary information respectively infrastructure and all needed assets for the implementation and execution of the experiment in the CAR installations. The document considers the implications of the initial results of methodology D2.1.1 as well inputs from first scenarios and requirements phase (D2.1.2), first blueprint architecture (D2.1.3), and provides some concrete requirements for security and data protection from WP5.
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<th>EXPERIMEDIA</th>
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<td>Experimentation</td>
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</tr>
</tbody>
</table>
Table of Contents

1. Executive Summary ........................................................................................................ 3
2. Introduction .......................................................................................................................... 4
3. Experiment Description ....................................................................................................... 5
   3.1. Learning Objectives ........................................................................................................ 7
   3.2. Experiment Procedure .................................................................................................... 7
       3.2.1. Phase 1: Preparation ................................................................................................. 7
       3.2.2. Phase 2: Execution ................................................................................................. 7
       3.2.3. Phase 3: Results analysis ....................................................................................... 7
   3.3. Experiment Aims ........................................................................................................... 9
   3.4. Assumptions and Preconditions .................................................................................... 10
   3.5. Parameters .................................................................................................................. 10
   3.6. Constraints .................................................................................................................. 11
4. Ethics and Privacy .............................................................................................................. 12
5. Experiment Design ............................................................................................................. 14
   5.1. Requirements ................................................................................................................ 14
   5.2. System Architecture ...................................................................................................... 14
       5.2.1. Modules .................................................................................................................. 15
       5.2.2. Deployment ............................................................................................................. 16
       5.2.3. Technical Assets .................................................................................................... 16
   5.3. Content Lifecycle .......................................................................................................... 18
       5.3.1. Content Authoring ................................................................................................. 18
       5.3.2. Content Management ............................................................................................. 18
       5.3.3. Content Delivery .................................................................................................. 18
   5.4. Risks ............................................................................................................................... 19
6. Plan for Implementation ...................................................................................................... 23
7. Conclusion .......................................................................................................................... 25
1. Executive Summary

This deliverable reports about the design and plans of EXPERIMEDIA’s CAR experiment. This experiment will focus on high quality content productions for remote sports analysis and training at live events. This document will describe the experiment design and plan for implementation and execution, providing developers and testbed operations with all the requirements needed for the implementation, as well as the experimental hypothesis and system architecture.

This deliverable is public and it can be used by anyone interested in an example experiment take places at CAR installations using EXPERIMEDIA.

The document is organised as follows:

- Section 1: It is the introductory section and contains the basic information of this deliverable, as well as the private or public character of the document.
- Section 2: It describes the main conditions and the setup around the idea of driving embedded experiments in CAR.
- Section 3: It contains a detailed description of the experiments with all assumptions, preconditions and parameters that should be met in order to drive the experiment in the way it was described.
- Section 4: In this section privacy and ethical issues are addressed.
- Section 5: This section describes the details on the conception, architecture and proposed execution and implementation of embedded experiment in CAR.
- Section 6: Detailed plan of the steps necessary for the realisation is described in this section.
2. Introduction

This deliverable describes the experiment design and plan for implementation and execution in one of the main facilities offered in the project: CAR (High Performance Centre). This experiment will provide to researchers all requirements needed for facility building, verification of methodology and best practice use cases for other experiments funded through the open call.

CAR is an organisation which gives support to sport so that it can be competitive at an international level, optimizing resources of the highest technical and scientific quality. The aim is to provide the athletes with everything necessary for their complete training so that we can share the knowledge of their activities. As a public company CAR is aimed to share the knowledge learned on the practice of athletes’ preparation to other real world applications. As it could be: the values of the sport competition techniques applied on the regular enterprise like is in sport or application of sport medicine procedures for regular patient rehabilitation and recovery.

In the CAR experiment, metadata, augmented reality and remote stream control is exploited. This experiment offers the opportunity to do research with synchronization of video, audio and metadata, and check how it improves the training process. The experiment will also offer trainers the opportunity to use a system helping them to see how streaming in the EXPERIMEDIA system works.

For the experiment, it has been necessary to choose a specific sport. Synchronized swimming has been selected. In a sport like this one, audiovisual processing would help a lot to improve the results of the trainings. The CAR experiment will make the interaction between athletes, coaches and other professionals involved in the preparation of the athletes possible. And this interaction will enable athletes to improve their performance.

Athletes, trainers and medical personnel involved in the experiment will test the experiment tools which will be provided in three phases: in the first phase the different components of the experiment will be installed and tested, in the second phase the experiment itself will be executed, and in a final phase the obtained results will be analysed.

This deliverable contains information extracted from deliverables D2.1.2, D2.1.3 and D5.1.1.
3. Experiment Description

The experiment will be based on the following scenario (explained in D2.1.2):

The focus of this experiment is to implement a new procedure to improve the accuracy and execution of the performance of the Syncro Dou Team on a mandatory routine of the Olympic Games.

The procedure will include the following phases to accomplish the goal:

1) Create Choreography

Creation of complete choreography based on the mandatory elements using their standard process interaction with Coaches and Swimmers, choreographers and musicians.

This routine will include the following technical elements to be performed:

   a) 240c
   b) Ballet Leg
   c) Double Spagat
   d) Conception Action
   e) Triple corkscrew twist
   f) Arms Boost
   g) Spagat with triple twist
   h) Barracuda with corkscrew twist
   i) Final routine

2) Perform accordingly to the Olympic Standards

All this elements will be performed at a specific point in time along the music.

3) To Record with Metadata

The performance will be recorded including video, audio and metadata.

Metadata will include:

- Start and finish point of each element,
- Start and finish point of underwater time or “apnea”,
- Quantization of the elements by numbers on the music beats,
- Sampled Telemetric Hearth rate registration and or thermography,
- A subjective qualitative marker of the coach as “Like it”

This procedure will be repeated with the most competitive team to be compared to.

4) To Review and Repeat
For the team that is training, it is important to be able to make corrections as fast as possible. In this regard, it is useful to have the comments from the trainer while they’re still in the water. The trainer might want to seek to a specific position of the video using the music tags instead of searching through the content the desired position to show as fast as possible what should be corrected.

One of the most relevant improving points to be implemented through this new method is the ability to overlay the numbers agreed in each routine, allowing the team to visualize with accuracy where they are in a specific point in time and the music, to be compared, between them or another competitive team of the international arena.

The trainer might also ask the swimmers to repeat a specific part of the choreography instead of doing everything again. The trainer has to be able to select the fragment of music, the team has to repeat it and the system has to record it.

Perhaps, one of the trainers couldn’t be on site that day, but his opinion is very important. That person might connect from home and see the same images the team is watching at the swimming pool. The person at home should be able to skip forward and backwards, once he has found the right fragment of the video he wants to comment, he could remotely control what the swimmers are watching on the television at the swimming pool.

All the people can use the screen as a whiteboard and put the marks on the screen. This information shouldn’t be stored, but, if another member of the team is connected remotely, he should be able to see it.

Figure 1. Routine quantization according to music beats.
3.1. Learning Objectives
The main objectives of this experiment are the following:

- To determine the feasibility of the collaborative work of the trainers
- To determine the actual improvement of the athletes performance

3.2. Experiment Procedure
The experiment will be carried out in three different phases:

3.2.1. Phase 1: Preparation
In this phase, the infrastructure will be tested in order to assure that all systems work properly. Cameras, sensors and all devices included in the experiment will be installed and tested in order to avoid any problem during the development of the experiment. These tests will be done with the supervision of the technical personnel involved in the experiment.

3.2.2. Phase 2: Execution
This phase will be divided in two sub phases:

- In the first one, audiovisual content captured by the CAR cameras will be made available locally and remotely allowing interactive manual annotation of the content. This will enable professionals to insert information related to the training sessions.
- In the second phase, manual video annotation from the coach and automatic annotation from the heart rate monitors or thermography cameras will be fused. The new enriched content will be used by coaches at the side of the pool during the training session or the physiologist staff at their posts after the training to follow the performance of the athletes.

3.2.3. Phase 3: Results analysis
In this phase, the results obtained from the experiment will be analysed. This analysis will allow trainers and athletes to take different decisions in order to improve the performance of the trainings, the efficiency and, in the future, to analyse the final results in a real competition.

Analysis of training and competition will be a continuous process looping again on the recording, quantization, metadata registration and video reviewing.

The analysis will include individual corrections on performance against the quantization agreed numbers and also performance to be compared to the other team recorded.

This should look like the following visual schema:
Figure 2. Technical routine schema compared between teams against time in seconds. Each point along the time axis shows when a certain element of the routine was performed with one team’s data above the line and the other team’s data below the line.

The time the team spend underwater (the apnea) is an important metric. With the annotation utility on real time or with the streamed video, underwater time of the team will be collected and added as metadata sync to the video and could be shown as the following figure.
Figure 3. Representation of the underwater time for three different teams coloured red, blue and green. The x-axis represents the time and the y-axis is just used to separate the three teams’ data.

3.3. Experiment Aims
The main aim of the experiment is to enhance the process to improve execution on quality and accuracy of the synchronized swimming routines and improve the training sessions of the team.

We enhance this creative process including:

1) Quality of the artistic result
2) Quality of the technical result
3) Training time required to achieve a particular result
4) Help keep trainer's mind concentrated on important tasks
5) Increase collaboration by also getting input from remote trainers
6) Increase collaboration by making it easier for athletes to make their own contributions to the choreography
7) Help choose the best athletes to participate in the performance (e.g. as opposed to who "stays on the bench" as we would say for football)

Starting with the daily way of work of the athletes’ team, the idea is to add:

- Music metadata: Offer the possibility of putting different tags at specific fragments of the music, or the possibility to hear the music in slow motion to be able to set the tags in an accurate manner
- Movements database: In this database, selected and cropped pieces of different videos with specific movements would be offered as well as the possibility of adding
information associated to a specific fragment of one specific video and making searches using the date, name of the choreography or other kind of relevant information

- Enhanced playback: It will be possible to synchronize the routines with music and metadata, as well as overlay music metadata over the video while the team is performing the choreography in situ.
- Remote control: At any time and in any place, it will be possible to look at the same video
- Piece selection: It is possible to select the piece of music that has to be reproduced while the team is training.

### 3.4. Assumptions and Preconditions

The following assumptions and preconditions should be met in order to carry out the experiment:

- All technical infrastructure should be properly working:
  - Wi-Fi
  - 3G for telephony outside the facility
  - Internet access points
- All devices should be ready for using and correctly placed:
  - Cameras
  - Sensors
  - Portable devices needed for training monitoring
- Trainers, athletes and all people involved in the experiments are aware that the training will be part of the experiment and have given consent.

### 3.5. Parameters

Parameters that will be measured in the experiments are:

- Final results
  - Will be defined as an overall execution and artistic impression made by jury officials that will be invited locally or remotely by videoconference to attend to the performance and simulate real competition environment with real scores.
- Relationship between Training time/ Efficiency
  - Thanks to the tagged video with the overlaid number of the music tick plus the improvement of the multiple availability of streams of the content of the training, the efficiency of the training process are expected to be improved, providing on one hand less time for the same routines learning curve, and on the other hand increase of quality execution due to the visual confirmation of the mistakes and synchronisation. Validation will be evaluated by the jury on regard the quality of the execution and by the time spent on to adjusting the performance of each routine to the agreed timing.
- Satisfaction level of trainers/athletes
• Each routine have included a tag of the coach: A subjective qualitative marker of the coach as “Like it” will be followed along the repetition process to identify the improvement. On the other hand athletes will have for its first time a number of the music tick overlaid on the video and will be able to appreciate visually, the synchronization between them. Feedback will be requested at the end of the process.

3.6. Constraints

The following constraints need to be taken into account:

ENVIRONMENT CONDITIONS

Environment conditions should be tested before the start of the experiment to avoid risks for the athletes and the results of the experiment that could emerge under high levels of temperature and humidity inside the pool site.

IMPACT ON TRAINING PROCESS

Due to the heavy training schedule, experiments can be altered or delayed due to sudden changes made in the training programs. Our experience with the Synchronized Swimming Team learns that training in creativity contents, creation of new choreographies, new technical elements or new music, make the coaches to readapt permanently their training schedules that may alter a pre-planned schedule for experiments.

APPROPRIATE RESOURCE MANAGEMENT

As the infrastructure building services have been designed to be provided in a non-stop way, and the 12 sports facilities will be common users of this building, there are constraints in making network services available at any time that have to be taken in account.

Requirements of big bandwidth for specific videoconference project may require an appropriate resource plan and delivery. As may be the same for meeting rooms or storage room if there are required for the experiments.

ACCESS TO FACILITIES FOR EQUIPMENT INSTALLATION AND TESTING

Most of the sporting facilities have a maintenance and cleaning period on an everyday basis. This period should be taken into account when planning the experiments.

Usually we may be looking for timeframes of operations that may not interfere with the training process, which use to be the same required for cleaning and maintenance.
4. Ethics and Privacy

D.5.1.1 has delivered a detailed set of ethical guidelines considering the EXPERIMEDIA project and its specification. Those principles will be integrated in adequate way into design of experiment as follow:

**INFORMED CONSENT**

Before participants will be asked to join the CAR experiments, they will be informed of the research objectives and all aspects of the research that might reasonably be expected to influence willingness to participate. The participants in the CAR experiment will also be informed of all other aspects of the research about which they enquire. If personal data of the athletes will be processed, informed consent is needed.

**DECEPTION**

The participants will not be deceived or mislead about the purpose and the general nature of the experiments. Neither will any other kind of information be withhold from them.

**DATA COLLECTION**

Personal data collected about the participants during the development of the experiment will be stored for as long as is necessary for the purposes for which the data were collected or for which they are further processed. This data will only be stored when the consent of the users is given and only for the purpose and lifetime of corresponding experiment’s session. There will be no commercial exploitation of this data.

**WITHDRAWAL FROM THE INVESTIGATION**

Participants will be informed about their rights to withdraw from the experiment at any time, irrespective of whether some incentive has been offered and accepted and to require the destruction of generated data collected with their contribution.

**OBSERVATIONAL RESEARCH**

CAR is a private venue, so this clause is not applicable.

**DATA PROTECTION REGULATION**

All personal data will be captured and processed according to the applicable data protection provisions, such as Directive 95/46/EC on the protection of individuals with regard to the processing of personal data and on the free movement of such data, including Article 29 Working Party 8/2010 opinion, and Directive 2002/58 on Privacy and Electronic Communications) and the Spanish data protection legislation that may be applicable.

**CONSORTIUM PARTNER RESPONSIBILITY**
EXPERIMEDIA partners are invited to monitor and follow CAR experiment. In case of any concern, it will be considered and treated accordingly.
5.  Experiment Design

As explained in D2.1.3, the CAR scenario focuses on using FMI technologies to monitor and measure sports performance for high performance athletes. By using this technology, the perception of performance will be increased. It will be also provided more efficient mechanisms to direct training plans.

High performance sports training is an extremely instrumented endeavour with lots of quantitative data collected about athletes’ physiology (e.g. heart rate, strength, etc.) and sport outcomes (e.g. times). The idea is that using advanced video analysis additional performance insights can be automatically generated and replace manual observations of the live event or video recordings.

In particular, using FMI will capture a richer memory of the training experience that can be analysed both in real-time at the track/pool side or later.

5.1.  Requirements

The following requirements need to be met:

- CAR venue must have good Wi-Fi coverage in order to guarantee the correct execution of the experiment
- CAR venue should have installed all devices needed for the development of the experiment: IP-HD-HS-Cameras, ambient sensors such as ambient and water temperature, humidity and outside temperature, microphones
- CAR venue should have available all trainers involved in the experiment
- CAR venue must enable that video stream should be streamed to mobile devices at any time and at any geographic location.

5.2.  System Architecture

The following picture shows the software components which will be deployed for the execution of the experiment at CAR.
5.2.1. Modules

**Camera encoder**, this module will acquire the streams produced by the fix high definition cameras deployed around the swimming pool, synchronised them and generate IP streams to the Input Manager as a normal encoder.

**Live Metadata Manager**, this component receives the real-time metadata including the music information, synchronised and inject it into the audio-visual feed(s).

**Training Session Manager** component, centralised the information flows of the training sessions, allowing the trainers to synchronise the music, the video and metadata acquisition, recording and transmission to different terminals and networks. The component manages the training session preparation and executions including the management of the audio-visual assets collected in the training sessions. To support these functionalities, the component includes data persistent, tasks management and frontends for the local and remote training.

**Training session UI**, these are the actual frontends of the Training session management component, which will allow remote and local trainers as well as the trainees to watch and annotate the sessions.
**Input Manager**, module manage the reception of all live content including audio, video and metadata from the Live metadata acquisition management and data flows between the Transcoder, Recorder and Device Adaptation Manager. It does also support relive and streams feeds from the VoD Manager.

**Device Adaptation Manager**, adapt the media content to different platforms without changing the audio or video codecs themselves. The content is fragmented and encapsulated for different devices and platforms.

**Transcoder**, the main objective of this module is to transcode in order to provide multi-quality support proving the same feed at different bitrates but aligning the GoPs so the player will be able to continuously adapt to network capabilities.

**Multi Quality Management**, this module coordinates the mutiquality content between the Transcoder and the Media Distribution, so the content is properly transcoded and the manifest of the multiqualities streams are properly generated.

**Media Distribution**, this module is in charge of the actual content delivery, which includes the continuous generation of the manifest, final packaging of the content and transport protocols. This module produce all multiplexes media output of the main distribution.

**Timeshift Manager**, this module is in charge of continuously record live streams for immediate playback on deferred. It allows the user to have DVR experiences such as rewind, pause or fast forward. The content is received from Device Adaptation Manager and it flows both to the AV repository and the Media Distribution Module.

**VoD Manager**, this module delivers pre-recorded video and audio streams to the Input Manager from a single source files per content or training session.

**Live metadata Acquisition management**, this module manage the reception of metadata and the time stamps from the Training Session Manager, SCADA infrastructure and sensors which are send to the Input Manager module to synchronise it with the video stream.

**Online AV** component, this element is the Audio-visual Component described in D2.2.1, which some modules are also been described in the architecture of the experiment.

### 5.2.2. Deployment

The above software will be deployed within the CAR premises except the mediaserver1, which is already online.

The Camera encoder requires specific hardware which will be provided by ATOS, while the rest of the platform will be hosted at CAR servers. Terminal devices will be provided by CAR and ATOS for the integration and testing.

### 5.2.3. Technical Assets

**GigaE Camera(s)**, a minimum of three of this high definition and high bit rate cameras will be included in the experiment.
SCADA, the swimming pool room as all the training facilities of the new building, is managed by a SIEMENS SCADA platform. The Training Session Management will send commands to play music in the room allowing the synchronisation of the training session, simulation partially or completely a competition scenario. The platform also provides environmental information from its own systems which will be included as metadata of the training session. The sensor data includes:

- Light
- Temperature
- Humidity
- Video
- Audio

Wearable's sensors, it is expected to have Physiology sensors from oximeters to HR or Thermo for the athletes.

Other sensors, the platform will allow additional sensors data provides information.

mediaserver1, this is an online server with the hardware and software capabilities to hold most of the components of the AV component including transcoding capabilities. It will act as a CDN to the experiment allowing multiple remote trainers join the same streams, without consuming unnecessary bandwidth to CAR as well as improving theirs QoE.

Local Media Server, this is a server which will be housed at the CAR data centre, and will include the Input Manager, VoD Manager, Device Adaptation Manager, Multi Quality Manager, Timeshift Manager and Media Distribution modules and the physical space for the Cache.

The Training Session Management Server will be hosted in a virtual machine, using cloud technology, which will be physically hosted by an Intel Blade B200, located in an Intel 5108 Chasis, with the following configuration:

- 4 blades (B200)
- 2xIntel Xeon E5650 2.66GHz /6c/80W/12MB cache/DDR3 1333MHz
- 96 GB RAM DDR-1333Mhz
- 2xHD146 Gb SAS 10k RPM
- 1x NIC UCS M81KR

This server is located at CAR data centre in the new building.

Camera encoder, a new server will be purchase after evaluating the hardware requirements of the proposed solution, this server will be deployed at the swimming pool rack to reduce the distance to the cameras.
Terminals, the trainers and other participants of the experiments will access to the Terminal applications through their already available laptops and tablets. Either CAR or ATOS would study the need of purchasing an additional tablet once the experiments starts if it is required to easy the adoption of some of the technologies.

Storage, 25TB of the 100TB storage capabilities available at the data centre of CAR will be reserve to the experiments to store video content associated to the training sessions.

5.3.  Content Lifecycle

5.3.1.  Content Authoring
In this scenario, the content relates to the athletes training and competitive event performance. Coaches are responsible for developing training plans and performance objectives. There are various sources of information from physiological sensors, human observations (e.g. how do I feel today), timing devices, and metadata automatically generated from video analysis algorithms. The use of video analysis for generation of metadata or even 3D reconstruction of humans advances the SOTA for CAR. Moving from video data to an understanding of what is happening is important. This can be an automated (e.g. video processing algorithm) or manual process (e.g. key frame annotation). There will clearly be some link to healthcare data (e.g. if the athlete is injured) and dietary information, although it has not been elaborated.

5.3.2.  Content Management
A record of an athletes' performance is expected to be maintained in a training system that provides coaches, physiotherapists, and other specialists with the necessary tools to record, search and access information about an individual. In addition, video content will be recorded in a digital asset management system that records audio/visual material and associated metadata about the video (e.g. how/when recorded). The challenge is to associate the "memory" of a training event as encoded in the video with "understanding" of what happened as recorded in the training system. The integration of different content management systems will be a key challenge. Real-time feedback and high precision timing is a key characteristic of this scenario. We have multiple sources of data that needs to be synchronised accurately over the training event timeline. In a localised situation (e.g. at a swimming pool), this synchronisation is possible as the system context is limited to a single location and will not be subject to networking effects or multiple contexts which we will see in remote interactive scenarios (e.g. REV-TV).

5.3.3.  Content Delivery
The consumers of content are coaches (local and remote) and athletes participating in a training event. During the live event, there's not much interaction with the digital media. For example, the athletes are not looking at their screens but are focused on their event. The coaches will make observations, will redirect or even terminate a session but the point is at the track/pool side. The digital representation is a rich memory of the experience not the experience itself. If a coach is at a remote location, the situation is different because their experience/perception of a training session will be entirely represented by digital media. However, a coach (remote or local) will only provide remote feedback rather than participating in the actual sport. The issue for delivery is therefore presenting a memory of the live event for review by all interested parties.
5.4. Risks
The following risks have been identified:

TRAINING AND COMPETITION LOGISTICS RISK

Competition plans use to be arranged at the beginning of the season and accordingly to all the teams adjust its training plans upon that. The most common issue recognized with the competition schedules is when an Olympic period finishes; all International Federations develop a new 4 years schedule, and this will affect the beginning of the next year.

Most of the local and national federations run on yearly budgets which are approved at the beginning of the year. Taking into account the crisis period we are facing, they are not able to close their year competition plans, pending on sponsors or available organizers.

TECHNICAL ISSUES ON INFRASTRUCTURE AND EQUIPMENT

As the facility is located in a new building with thousands of network connection points, a couple of thousand electricity outlets and hundreds of SCADA sensor devices, which includes SIEMENS sensors and domotics infrastructure for managing the building temperatures, lights and alarms systems, the probability of failure, especially in the beginning of the implementation and use of the building, have to be taken into account.

Data-centre infrastructure requires a long period of testing to warranty stability. Unfortunately, we have not enough budgets in this project to warranty a PIER 4 infrastructure\(^1\), ours complies between PIER 2 and 3, so potentially, short downtimes may be required during the period of use and may affect schedules and services. Until today we have not experienced any.

Sporting equipment does also have an initial process of adaptation and sometimes the factory mistakes appears within the first months of its use, sometimes creating a process of appropriate diagnostics and change if it’s required.

CONTENT DELIVERY RISKS

To warranty a selected delivery of contents under an easy and secure environment is part of the challenging issues and risks to be taken into account. The EXPERIMEDIA experiments will distribute content as part of the training process including video, audio and personal metadata addressing specific groups; those contents are subjected to risk upon the described on the following chapter on network and data attacks.

NETWORK AND DATA ATTACKS

Based on an open Wi-Fi network, as we will be running, with more than 600 potential users online, attacks to the data or the network services have to be taken into account.

Without security measures and controls in place, data might be subjected to an attack.

\(^1\) PIER is a standard of redundancy for data-centres. PIER 4 is a fully redundant system.
Some attacks are passive, meaning information is monitored; others are active, meaning the information is altered with intent to corrupt or destroy the data or the network itself.

Networks and data are vulnerable to any of the following types of attacks if there is not a security plan in place.

**Eavesdropping**

In general, the majority of network communications occur in an unsecured or "cleartext" format, which allows an attacker who has gained access to data paths in your network to "listen in" or interpret (read) the traffic. When an attacker is eavesdropping on your communications, it is referred to as sniffing or snooping. The ability of an eavesdropper to monitor the network is generally the biggest security problem that administrators face in an enterprise. Without strong encryption services that are based on cryptography, your data can be read by others as it traverses the network.

**Data Modification**

After an attacker has read your data, the next logical step is to alter it. An attacker can modify the data in the packet without the knowledge of the sender or receiver. Even if you do not require confidentiality for all communications, you do not want any of your messages to be modified in transit. For example, if you are exchanging purchase requisitions, you do not want the items, amounts, or billing information to be modified.

**Identity Spoofing (IP Address Spoofing)**

Most networks and operating systems use the IP address of a computer to identify a valid entity. In certain cases, it is possible for an IP address to be falsely assumed—identity spoofing. An attacker might also use special programs to construct IP packets that appear to originate from valid addresses inside the corporate intranet.

After gaining access to the network with a valid IP address, the attacker can modify, reroute, or delete your data. The attacker can also conduct other types of attacks, as described in the following sections.

**Password-Based Attacks**

A common denominator of most operating system and network security plans is password-based access control. This means your access rights to a computer and network resources are determined by who you are, that is, your user name and your password.

Older applications do not always protect identity information as it is passed through the network for validation. This might allow an eavesdropper to gain access to the network by posing as a valid user.

When an attacker finds a valid user account, the attacker has the same rights as the real user. Therefore, if the user has administrator-level rights, the attacker also can create accounts for subsequent access at a later time.
After gaining access to your network with a valid account, an attacker can do the following:

- Obtain lists of valid user and computer names and network information.
- Modify server and network configurations, including access controls and routing tables.
- Modify, reroute, or delete your data.

**Denial-of-Service Attack**

Unlike a password-based attack, the denial-of-service attack prevents normal use of your computer or network by valid users.

After gaining access to your network, the attacker can do the following:

- Randomize the attention of your internal Information Systems staff so that they do not see the intrusion immediately, which allows the attacker to make more attacks during the diversion.
- Send invalid data to applications or network services, which causes abnormal termination or behaviour of the applications or services.
- Flood a computer or the entire network with traffic until a shutdown occurs because of the overload.
- Block traffic, which results in a loss of access to network resources by authorized users.

**Man-in-the-Middle Attack**

As the term indicates, a man-in-the-middle attack occurs when someone between you and the person with whom you are communicating is actively monitoring, capturing, and controlling your communication transparently. For example, the attacker can re-route a data exchange. When computers are communicating at low levels of the network layer, the computers might not be able to determine with whom they are exchanging data.

Man-in-the-middle attacks are similar to a situation in which a person pretends to be somebody else in order to read your message. The person on the other end might believe it is you because the attacker might be actively replying as you to keep the exchange going and gain more information. This attack is capable of the same damage as an application-layer attack, described later in this section.

**Compromised-Key Attack**

A key is a secret code or number necessary to interpret secured information. Although obtaining a key is a difficult and resource-intensive process for an attacker, it is possible. After an attacker obtains a key, that key is referred to as a compromised key.

An attacker uses the compromised key to gain access to a secured communication without the sender or receiver being aware of the attack. With the compromised key, the attacker can decrypt or modify data, and try to use the compromised key to compute additional keys, which might allow the attacker access to other secured communications.
**Sniffer Attack**

A sniffer is an application or device that can read, monitor, and capture network data exchanges and read network packets. If the packets are not encrypted, a sniffer provides a full view of the data inside the packet. Even encapsulated (tunnelled) packets can be broken open and read unless they are encrypted and the attacker does not have access to the key.

Using a sniffer, an attacker can do the following:

- Analyse your network and gain information to eventually cause your network to crash or to become corrupted.
- Read your communications.

**Application-Layer Attack**

An application-layer attack targets application servers by deliberately causing a fault in a server's operating system or applications. This results in the attacker gaining the ability to bypass normal access controls. The attacker takes advantage of this situation, gaining control of your application, system, or network, and can do the following:

- Read, add, delete, or modify your data or operating system.
- Introduce a virus program that uses your computers and software applications to copy viruses throughout your network.
- Introduce a sniffer program to analyse your network and gain information that can eventually be used to crash or to corrupt your systems and network.
- Abnormally terminate your data applications or operating systems.
- Disable other security controls to enable future attacks.
### 6. Plan for Implementation

Below, the approximate timeline can be found:

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<tbody>
<tr>
<td><strong>Network Infrastructure</strong></td>
<td>In progress</td>
<td>Testing</td>
<td>Available</td>
<td>Phase 1</td>
<td></td>
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<tr>
<td><strong>Servers and storage</strong></td>
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<td>Phase 1</td>
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<tr>
<td><strong>Sensors research</strong></td>
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<td>First prototypes</td>
<td>Phase 1</td>
<td>Phase 2</td>
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<tr>
<td><strong>Sensor deployment</strong></td>
<td>First prototypes deployed</td>
<td>Phase 1</td>
<td>Phase 2</td>
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<tr>
<td><strong>AV and metadata acquisition</strong></td>
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<td>Phase 1</td>
<td>Deployed &amp; available V2</td>
<td>Phase 2</td>
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<tr>
<td><strong>Multi camera synchronization</strong></td>
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<td><strong>AV transcoding</strong></td>
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<td>Phase 2</td>
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<td><strong>AV streaming</strong></td>
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<td><strong>AV &amp; metadata recording</strong></td>
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<td>Phase 2</td>
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<td><strong>AV DVR</strong></td>
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<td>Phase 2</td>
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<tr>
<td><strong>AV &amp; metadata synchronization</strong></td>
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<td>Phase 1</td>
<td>Deployed &amp; available V2</td>
<td>Phase 2</td>
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<tr>
<td><strong>Training sessions management</strong></td>
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<td>Phase 1</td>
<td>Deployed &amp; available V2</td>
<td>Phase 2</td>
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<tr>
<td><strong>Training User Interfaces</strong></td>
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<td>Deployed &amp; available V2</td>
<td>Phase 2</td>
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<td>Experiment</td>
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Due to the Olympic period, implementation plan for Synchronized swimming may wait after Olympics to do not interfere with the present training plan. Other related sports may be used to test some equipment and devices in the meanwhile.
7. Conclusion

This document describes the objectives of the driving experiment at CAR: to improve the training of synchronised swimming athletes while assisting the project in understanding requirements and methods for experimentation.

Ethical and privacy issues as well as risks have been considered and documented along with the system architecture and components required to implement the experiment.

An initial plan for implementation has been described which will be updated (outside of this document) as work proceeds.