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FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL

Risk Assessment of the "Undetected Simultaneous Transmissions" Phenomenon

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Contents

List of Figures in Main Document

List of Figures in Annexes

Error! No table of figures entries found.

List of Tables in Main Document

List of Tables in Annexes

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EXECUTIVE SUMMARY

CHAPTER 1 – About this document

1.1 Purpose and Scope

The purpose of this document is to define and scope the phenomenon of Undetected Simultaneous Transmissions (USiT), gather knowledge about the subject, characterize the associated safety risk for ATM and propose a way forward to the community.

Risk characterization is based on a generic understanding of the phenomenon. Tools and information are provided to the persons in charge at local level (within ANSP) to tailor the approach, assess risk locally and highlight related elements of the decision making process.

1.2 Audience

The target audience is the persons in charge, at local level, of assessing risk associated to the USiT phenomenon.

1.3 Reference

ED136: Voice over internet protocol (VoIP) Air Traffic Management (ATM) system operational and technical requirements
EUROCAE
2009-02

Doc-4444: PANS-ATM
15th edition
ICAO
2007-11

AG-AP: European Action Plan for Air Ground Communications Safety
Edition 1.0
EUROCONTROL
2006-05

1.4 Overview

CHAPTER 1 – About this document: provides general information on this report.

CHAPTER 2 – Introduction: provides the context and description of the phenomenon.

CHAPTER 3 – Impact on the System: describes and analyze the impact of this phenomenon on the ATM System.

ANNEX 1 – Points of Contact: Provides the list of organizations involved and their related points of contact

ANNEX 2 – Cross-coupling modes of operation: provides a brief description of Cross-coupling of frequencies

ANNEX 3 – Call Sign Similarity: provides a brief description and reference on Call Sign Similarity Program

ANNEX 4 –Data Analysis: provides the analysis of available data.

CHAPTER 2 –Introduction

2.1 Current Context

The phenomenon of Simultaneous Transmissions is not new. However, multiple ANSP (incl. DFS, Skyguide, DSNA…) have identified more frequent occurrences contributing in some cases to safety related incidents.

As this question was raised to the Safety Improvement Sub-Group (SISG), mandate was given to investigate the risk associated with this phenomenon and its evolution.

2.2 Phenomenon

The phenomenon of “Detection of simultaneous radio transmissions” is described in Section 2.5 of ED136:

“Situations arise when two or more radio transmissions occur, simultaneously, on the same frequency. In this context ‘simultaneous’ is defined as two or more transmissions that overlap in such a way that the controller is not aware that more than one transmission has occurred leading to a potential safety hazard.”

In the context of this initiative, the notion of “simultaneous” is extended to transmissions that overlap in such a way that the controller or a pilot is not aware that more than one transmission has occurred.

2.2.1 The sources

Multiple scenarios have been identified for the occurrence of this phenomenon; they could be summarized as follow:

- 2 pilots transmitting simultaneously
  - on the same frequency with one ground receiver (also known as “stepped on transmission”)
  - on the same frequency with two or more ground receivers being connected to a “Best Signal Selection” (BSS) system (also known as “call swamping”)
  - on 2 frequencies that are cross-coupled[1] by the controller (also known as “call-blocking”)
- Simultaneous transmissions by the ATCO and a pilot (also known as “stepped on transmission”):

1 Frequency coupling is a facility allowing 2 or more frequencies to be operated as a single one. All users will receive transmissions made on all coupled frequencies (F1 and F2 are coupled, TX made on F1 are retransmitted after a variable (short) delay on F2). This functionality is required when sectors are merged (or coupled), when military a/c using UHF frequency are operating within a sector (applicable only to some countries/ANSP). For further details on cross-coupling modes of operation, please refer to ANNEX 2 –.

  - o on a single frequency
  - o on frequencies that are in a cross-coupled group at the CWP; (the pilot makes a transmission on a coupled frequency while the Controller is transmitting to frequencies in the cross-coupled group).
- or any combination of those scenarios

In addition to this description and based on data from occurrence investigations, “Multi-receiver Blindspot” is added as being a source of loss of signal (or transmission); which could also be considered in the context of Undetected Simultaneous Transmissions. It corresponds to wide range radio field operations used in difficult terrain leading to lack of reception for some pilots and to the signal being lost.

Figure 1 presents the different sources of the phenomenon.

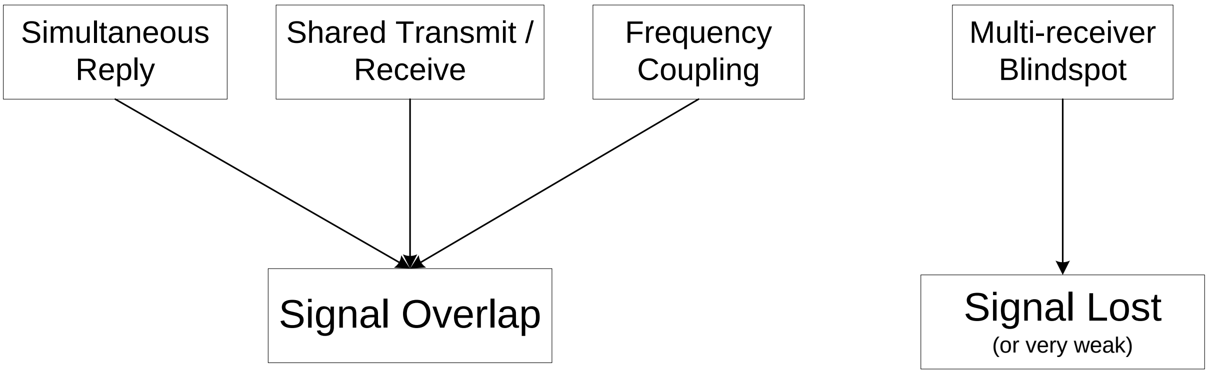

Figure 1: Sources of Simultaneous Transmissions

2.3 The mechanism

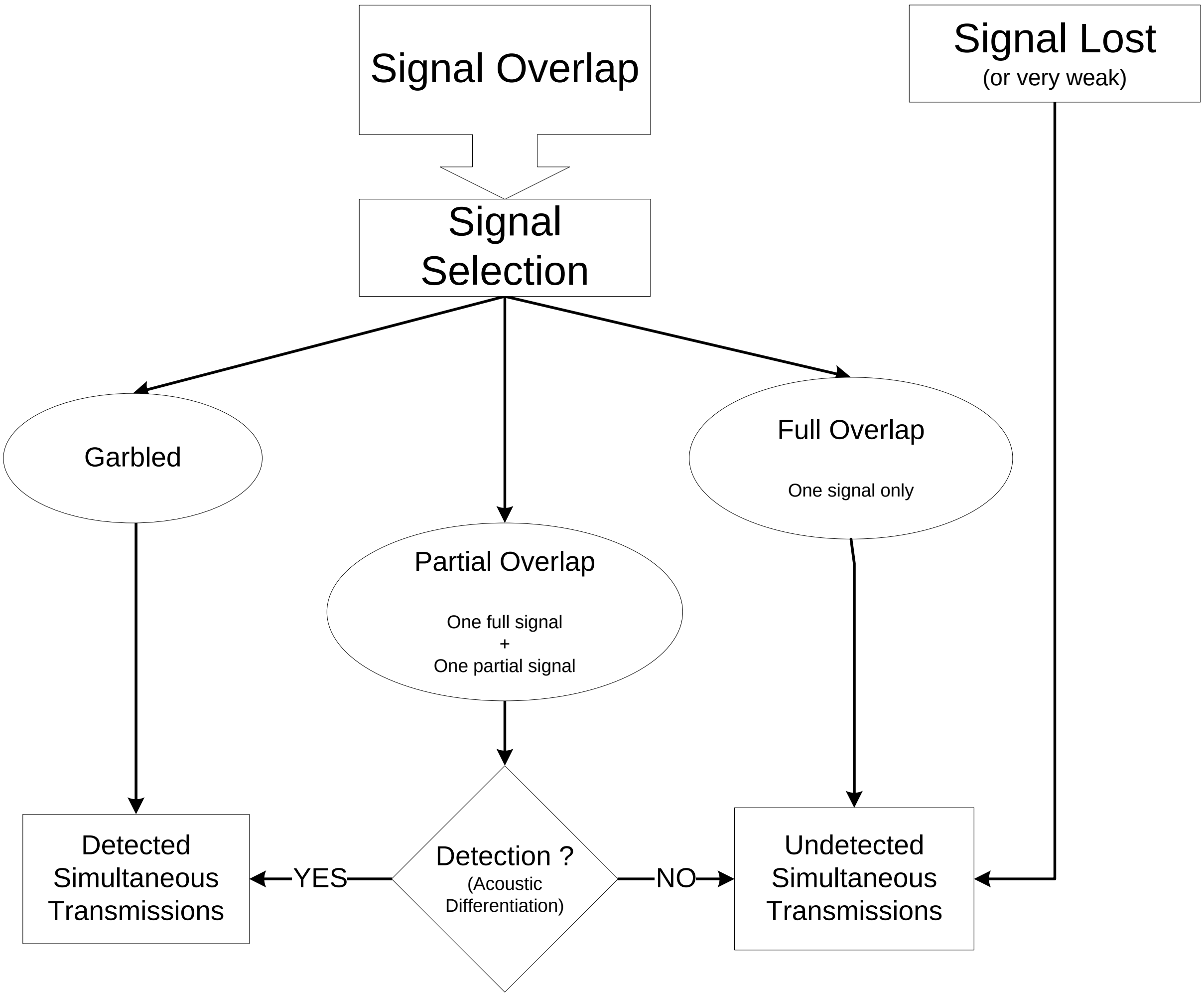

Figure 2: Uncoordinated Frequency Sharing

2.3.1 Signal Selection

As signal overlap, the system is naturally making a selection on the type of overlap, the relative strength of the signals, the frequency variation, distance between transmitters and receivers, use of one or multiple ground receivers…

2.3.2 Full overlap

The stronger signal totally covers the weaker one (without detection) as presented in Figure 3. Although both signal are transmitted, physical laws cause the receiver to eliminate the weaker signal leading to only one signal being transmitted to (or received by) the ATCO.

Although some garbling may been heard in these circumstances depending on the type of RT equipment/architecture, no (or little) detection can be expected.

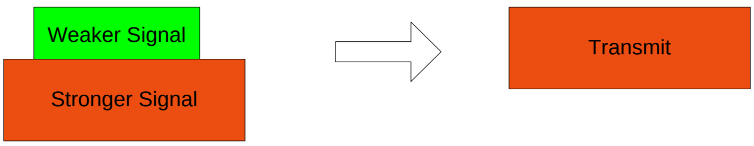

Figure 3: Full Overlap[2]

2.3.3 Partial Overlap

The weaker signal is not totally covered by the strongest one as presented in Figure 4. This could lead to acoustic differentiation (also called “clipping”) and, in some cases, detection of the phenomenon depending on how much longer the weaker signal is in regard to the stronger one.

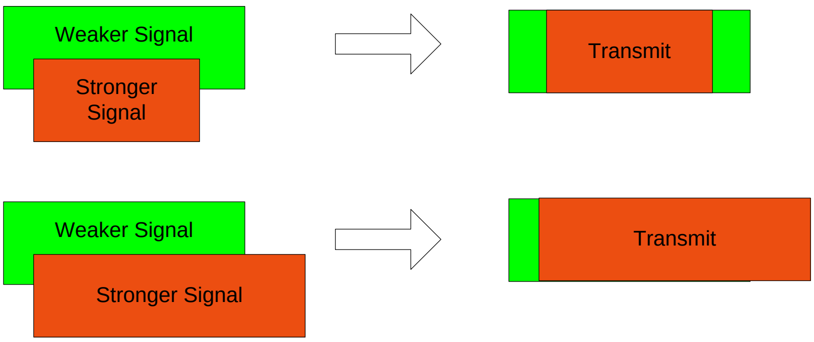

Figure 4: Partial Overlap

2.3.4 Garbled

Signals are of equivalent strength and they are both transmitted with (detected) garbling as presented in Figure 5. The phenomenon is most probably detected as the garbling is heard by the ATCO.

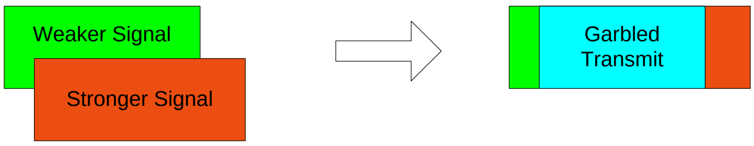

Figure 5: Garbled Signal

2.3.5 Detection

The detection mechanism is simplified in Figure 6.

[2] “transmit” in the figure should be understood as transmitted to the ATCO

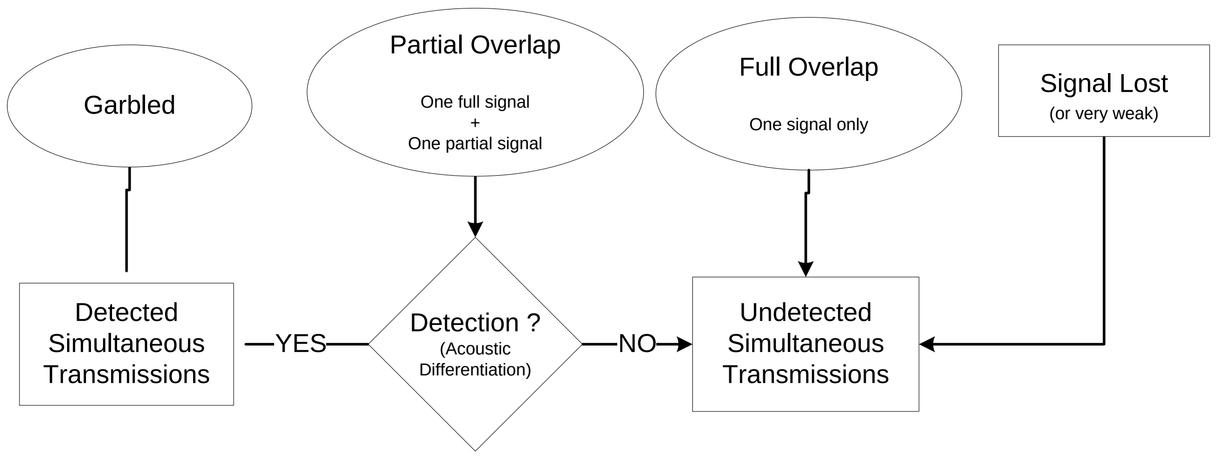

Figure 6: Detection

As the signal is Garbled, the detection can be expected to be straight-forward by the ATCO leading to Detected Simultaneous Transmissions.

Considering the cases of Full Overlap and Lost Signal, detection will be very poor leading to Undetected Simultaneous Transmissions.

In the case of Partial Overlap, depending on the type of overlap, the relative strength and duration of the signals, the callsign clarity, ATCO workload, the architecture of the ground Voice Communication chain, and detection of simultaneous transmissions could vary.

CHAPTER 3 –Impact on the System

3.1 Operational Scenarios

Based on chapter 2.2.1, 3 scenarios have been identified as a starting point for the characterization of the risk as shown in Table 1.

Name	Communication initiated by	Simultaneous transmissions by
Simultaneous Replies	ATCO	Pilot 1 & Pilot 2
Inefficient Management of Conflict	ATCO	Pilot & ATCO
Lost or Delayed Information	Pilot 1	Pilot & ATCO

Table 1: Scenarios

Those scenarios are further described in the following sections.

3.1.1 Scenario 1 – Simultaneous Replies

An ATCO has at least 2 a/c under his control. He provides an instruction to the Pilot of the 1st a/c (“Pilot 1”).

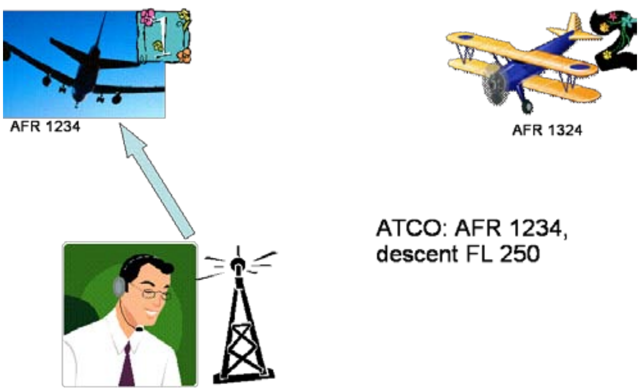

Figure 7: Scenario 1 – Step 1

For some reason, the Pilot of the 2nd a/c (“Pilot 2”) considers that the instruction applies to him. Both Pilots (Pilot 1 and Pilot 2) readback simultaneously (e.g.: due to Call Sign confusion, expectation bias…).

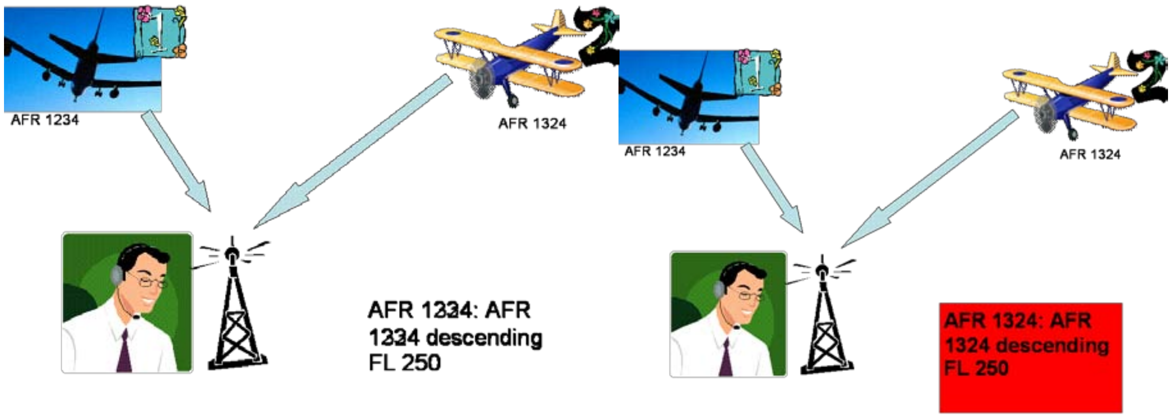

Figure 8: Scenario 1 – Step 2

Depending on relative difference between the strengths and timing of the 2 incoming signals, the local architecture, etc; the ATCO hears one message clearly, some garbling or some partial overlap of the messages.

3.1.2 Scenario 2 -Inefficient Management of Conflict

An ATCO has at least 2 a/c under his control. He needs to provide an instruction to Pilot 1; the urgency of this message is considered in the analysis of this scenario.

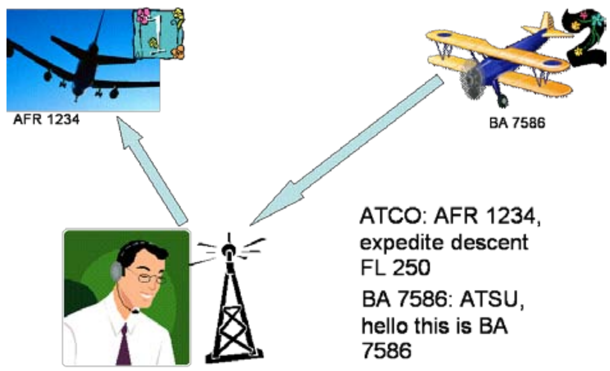

Figure 9: Scenario 2 – Step 1

At the same moment the ATCO makes his communication to Pilot 1, Pilot 2 makes a request to the ATCO.

Figure 10: Scenario 2 – Step 2

Depending on relative difference between the strengths and timing of the message from the ATCO and from Pilot 2; Pilot 1 hears some garbling, partial overlap of the messages or one message clearly.

3.1.3 Scenario 3 - Lost or Delayed Information

An ATCO has at least 2 a/c under his control. Pilot 1 makes a request.

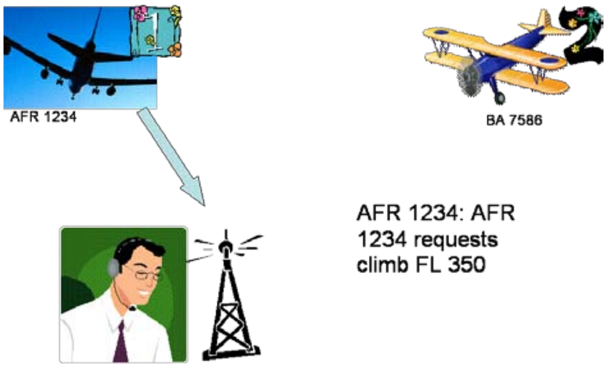

Figure 11: Scenario 3 – Step 1

The subsequent response by the ATCO is simultaneous to a request made by Pilot 2.

Figure 12: Scenario 3 – Step 2

Depending on relative difference between the strengths and timing of the message from the ATCO and from Pilot 2; Pilot 1 hears some garbling, partial overlap of the messages or one message clearly.

3.2 Parameters/Factors

The following parameters or factors are linked to the phenomenon, either as a contribution or as a barrier (strong or weak) in the system.

They have been considered when further understanding the different scenarios as described in section 3.3.

- Frequency use/load (high, very low…)
- Traffic load
- R/T discipline (e.g.: a/c calling "too" early on a given frequency)
- Use of several receivers to cover a wide sector

- The high quality of current frequency conditioning by the transmitters is responsible for the accurate compliance of the generated signal. Hence, no audible feedback (voice-over) is generated during simultaneous transmissions. (improved transmitters accuracy)
- AM-receivers eliminate a second weaker signal at the output because of their technical features.
- Use of very similar callsigns leading to limited/no detection by the ATCO
- Collapsing/Grouping of sectors (single sector operation)
- Significant differences of the received signals due to huge distances
- Significant differences of the received signals due to aircraft equipment
- Areas with wide coverage to deal with or condition of environment and landscape (mountains, valleys). Super refractions leading to reception of calls using the same frequency in another (far away) area (incl. propagation)

3.3 Barrier Analysis

3.3.1 Scenario 1 – Simultaneous Replies

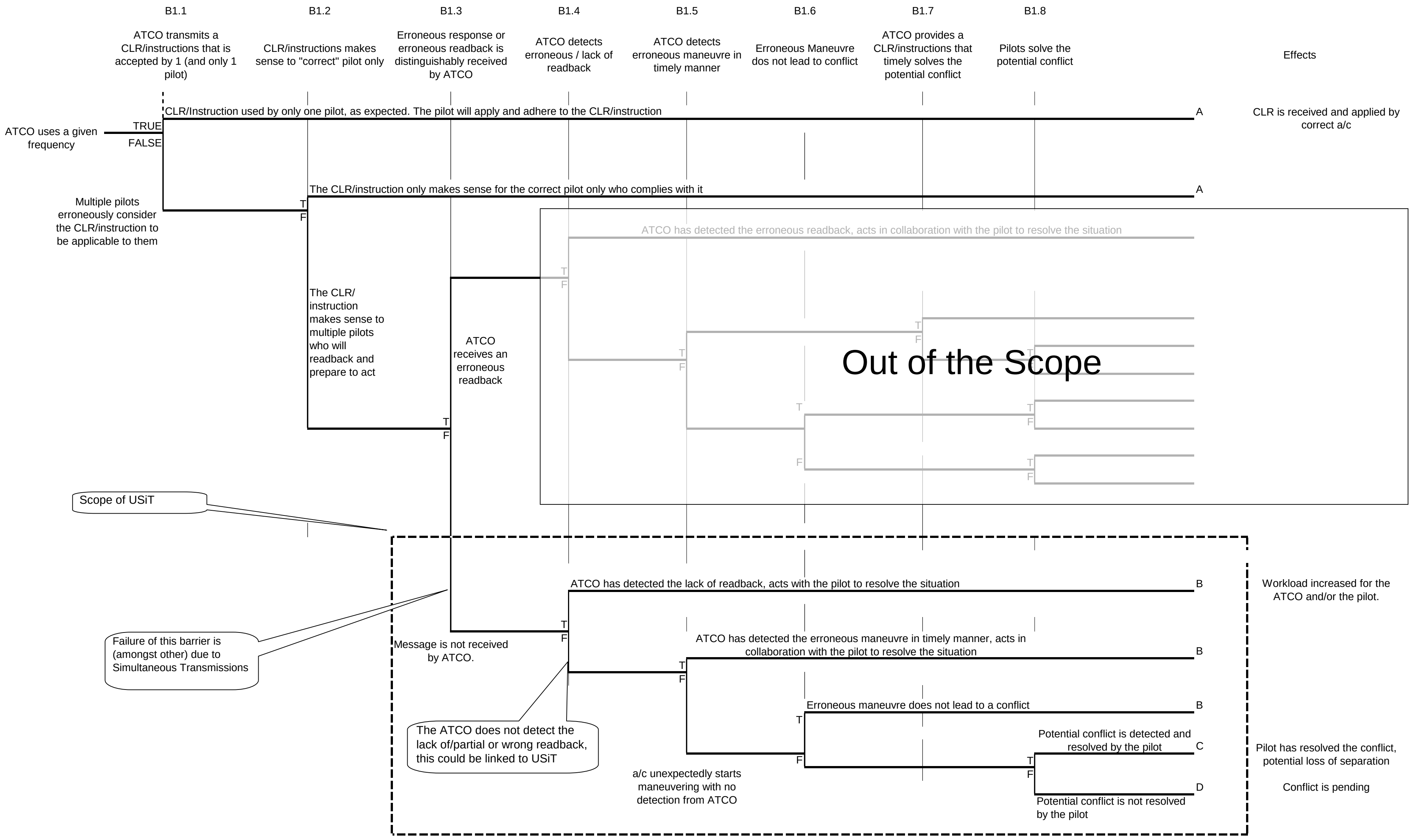

Figure 13: Event Tree - Scenario 1

3.3.1.1 Barrier B1.1 - ATCO transmits an instruction that is accepted by (only) one pilot

This barrier tries to integrate the fact that for many reasons (e.g.: Call Sign Similarity, expectation bias…), several pilots might consider an instruction to apply for them.

For more details on CSS, see ANNEX 3 –.

This barrier has been understood as relying heavily on good R/T practices (as recommended by Doc-4444).

3.3.1.2 Barrier B1.2 - Instruction makes sense to "correct" pilot only

Before reading back and eventually applying any instruction, it should make sense in the context of the current flight.

Although the efficiency of this barrier highly depends on the environment and traffic configuration; it is understood that if the instruction or the communication itself is unclear, the pilot and ATCO will in most cases question the instruction/request.

Example of expectation bias that might lead the "wrong" pilot into reading back and, eventually, applying the instruction:

> Pilot 1 ("correct" pilot) is at FL300; Pilot 2 ("wrong" pilot) is at FL220. ATCO instructs Pilot 1 to "descent FL 270". The expectation bias might lead pilot 2 in understanding "descent FL170"

3.3.1.3 Barrier B1.3 - Erroneous response or erroneous r/b is distinguishably received by the ATCO.

As the transmission of the read back is received by the ATCO; he'll either receive:

a. The correct r/b
   - As it is the strongest one
     NB: use of BSS would make it more likely that the other signal is filtered out to a level where is totally undetectable by the ATCO.
   - As it is the first one in couple situation
     NB: as soon as the retransmission starts on a coupled frequency, it blocks all subsequent reception on all coupled frequencies until that frequency becomes empty (see ANNEX 2 –).

b. The wrong r/b
   Same as for the "correct" r/b but in this case the "wrong" one is the strongest or the 1st one.

c. Garbling
   The 2 transmissions are of the same strength (from 0 to 8dB difference) on the same frequency on the same receiver.
   NB: If the 2 transmissions happen on 2 (different) coupled frequencies; there will be no garbling possible (see "a." and "b." here above)

d. Partial r/b
   This case is linked to the 3 previous ones. It should only be considered as a partial overlap if there is a chance of detection by ATCO.
   For the ATCO to detect a partial overlap, the suppressed signal has to last, in function of the system architecture, 0,5 to 1s (in coupled frequencies situation) more than the other.

3.3.1.4 Barrier B1.4 - ATCO detects erroneous/lack of r/b

Failure of this barrier could be for multiple reasons:

- ATCO is disturbed and does not hear the wrong r/b
- ATCO assumes a partial r/b as being correct
- Expectation bias
- …

It is understood that:

- o Doc-4444 clearly states that r/b is part of R/T rules
- o If no r/b is received by the ATCO, he will re-issue the instruction
- o In some peculiar cases (busy airspace, TMA…) the use of r/b is not always perfectly followed
- o ATCO's expectation bias could be a factor.

In this context, the barrier is considered as efficient; however the exposure is very high so the total number of occurrences might be high.

NB: need to improve awareness of ATCO and supervisors on this subject and the role of r/b and good R/T practices.

3.3.1.5 Barrier B1.5 - ATCO detects erroneous maneuver

If the ATCO has not picked up the lack of r/b, he will probably be busy on other situations and not pick up early the non compliance with the instruction. No instruction is understood as being more important than another in most case. Only exception will be in case of safety critical situations (STCA, separation already lost…).

In pure procedural environments, this barrier does not exist.

In concerned environment (e.g.: En-Route), route adherence monitoring tools (or equivalent) would support the detection of the non-adherence by the ATCO. This is difficult to apply for busy environment (busy TMA…).

3.3.1.6 Barrier B1.6 - Erroneous maneuver does not lead to conflict

It is recognized that not all non-adherence to an instruction would lead to a potential conflict. This depends high on the concerned airspace, the traffic load, the environment, etc.

Only a local assessment would provide an indication of the effect of non-adherence to an instruction.

3.3.1.7 Barrier B1.7 - ATCO provides an instruction that solve the potential conflict and Barrier B1.8 - Pilot solves the potential conflict

Those 2 barriers are standard activities for ATCO and pilots; their efficiencies depend on the detection of the potential conflict (i.e. this sends the reader back to the efficiency of barriers B1.3, B1.4 and B1.5).

3.3.2 Scenario 2 -Inefficient Management of Conflict

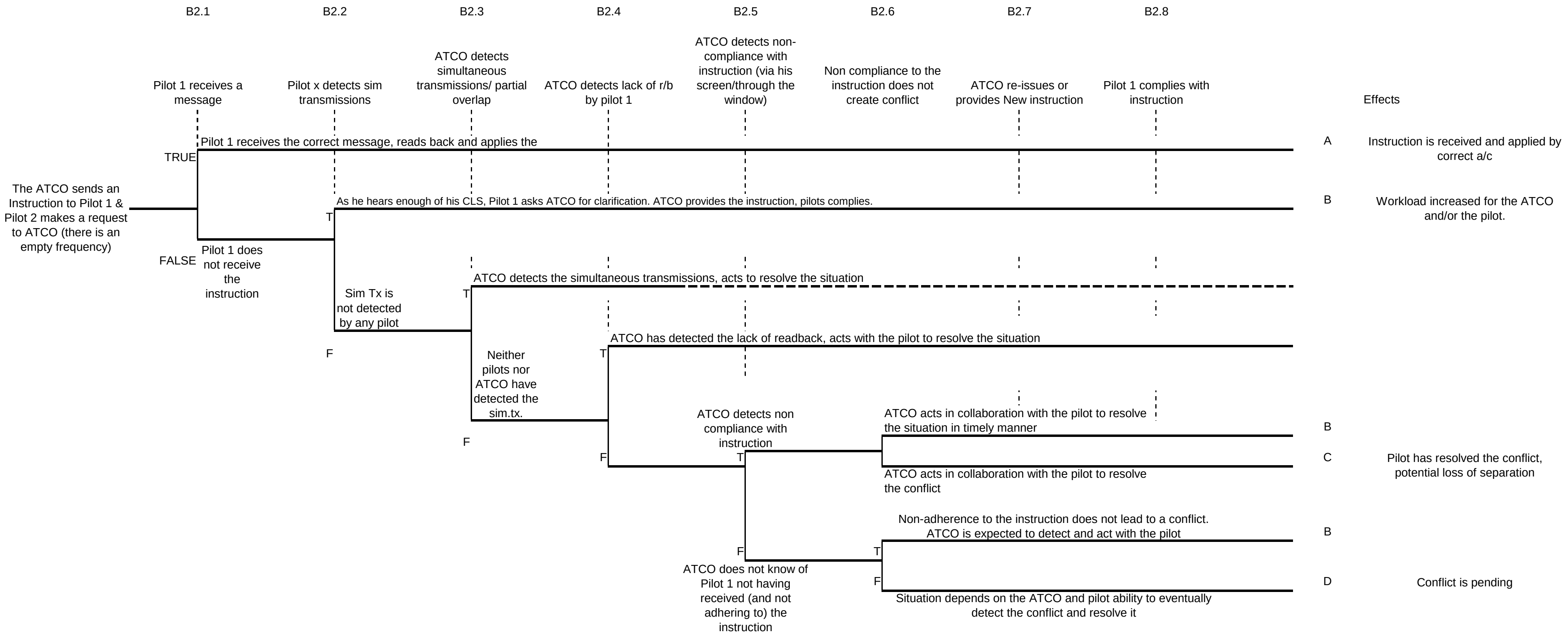

Figure 14: Event Tree - Scenario 2

3.3.2.1 Barrier B2.1 – Pilot 1 receives the message form the ATCO

In this scenario, the double transmissions happen on a sequence of communication initiated from the ground.

As the ATCO detects that the frequency is "free", he issues his instruction to Pilot 1. Pilot 2 initiates a request at the same moment as he, too, detects that the frequency is "free".

The fact that frequencies are coupled (simplex or duplex coupling –see ANNEX 2 –) might increase the chance for simultaneous transmissions.

3.3.2.2 Barrier B2.2 - Pilot x detects simultaneous transmissions

Detection of the simultaneous transmission by a pilot is not straight forward.

Pilot 1 (who should be the receiver of the instruction) will only recognize that he is concerned if he hears enough of his Call Sign in the message. It is understood that, only in that case, he would ask the ATCO for clarification.

Pilot x (any pilot who's on the frequency, other than Pilot 1) will most probably not detect the simultaneous transmission and, as it is not part of R/T rules as in Doc-4444, will not call for "blocked transmissions" on the frequency.

For those reasons, this barrier is considered as very weak, there is little chance that any pilot would detect the simultaneous transmissions.

3.3.2.3 Barrier B2.3 - ATCO detects simultaneous transmissions

It is understood that if simultaneous transmissions fully overlap (call from Pilot 2 is not heard), the barrier does not exist. ATCO would only know about Pilot 2 request when Pilot 2 re-issues it.

In case of partial overlap (non overlapping message has to be at least 0,5s longer -1s when frequencies are cross-coupled; depending on the system architecture), there is a chance of detection.

For those reasons, this barrier is considered as very weak, there is little chance that the ATCO would detect the simultaneous transmissions.

NB1: As the ATCO is transmitting, he blocks the frequency so the fact that there is one or multiple receivers/transmitters or that BSS is used, has no effect.

NB2: There is currently no equipment on the market (Double Side Band AM VHF voice communications) that would support the detection by ATCO (or pilots).

NB3: General comment, reducing the load of the frequency will reduce the probability of simultaneous transmissions. [Data Link Services as foreseen today will not completely solve the problem, might reduce the load on the voice communications and thus the probability of double transmissions.]

3.3.2.4 Barrier B2.4 - ATCO detects lack of r/b by pilot 1

Same as for 3.3.1.4 Barrier B1.4 - ATCO detects erroneous/lack of r/b

3.3.2.5 Barrier B2.5 - ATCO detects non-compliance with the instruction

If the ATCO has not picked up the lack of r/b, he will probably be busy on other situations and not pick up early the non compliance with the instruction. No instruction is understood as being more important than another with the (only) exception being the case of safety critical situations (STCA, separation already lost…).

In pure procedural environments, this barrier does not exist.

In concerned environment (e.g.: En-Route), route adherence monitoring tools (or equivalent) would support the detection of the non-adherence by the ATCO. This is difficult to apply for busy environment (busy TMA…).

3.3.2.6 Barrier B2.6 – Non compliance with the instruction does not lead to conflict

Same as for 3.3.1.6 Barrier B1.6 - Erroneous maneuver does not lead to conflict.

3.3.2.7 Barrier B2.7 - ATCO re-issues or provides a new instruction and Barrier B2.8 – Pilot 1 complies with the instruction

Those 2 barriers are standard activities for ATCO and pilots; their efficiencies depend on the detection of the potential conflict (i.e. this sends the reader back to the efficiency of barriers B2.2, B2.3, B2.4 and B2.5).

3.3.3 Scenario 3 - Lost or Delayed Information

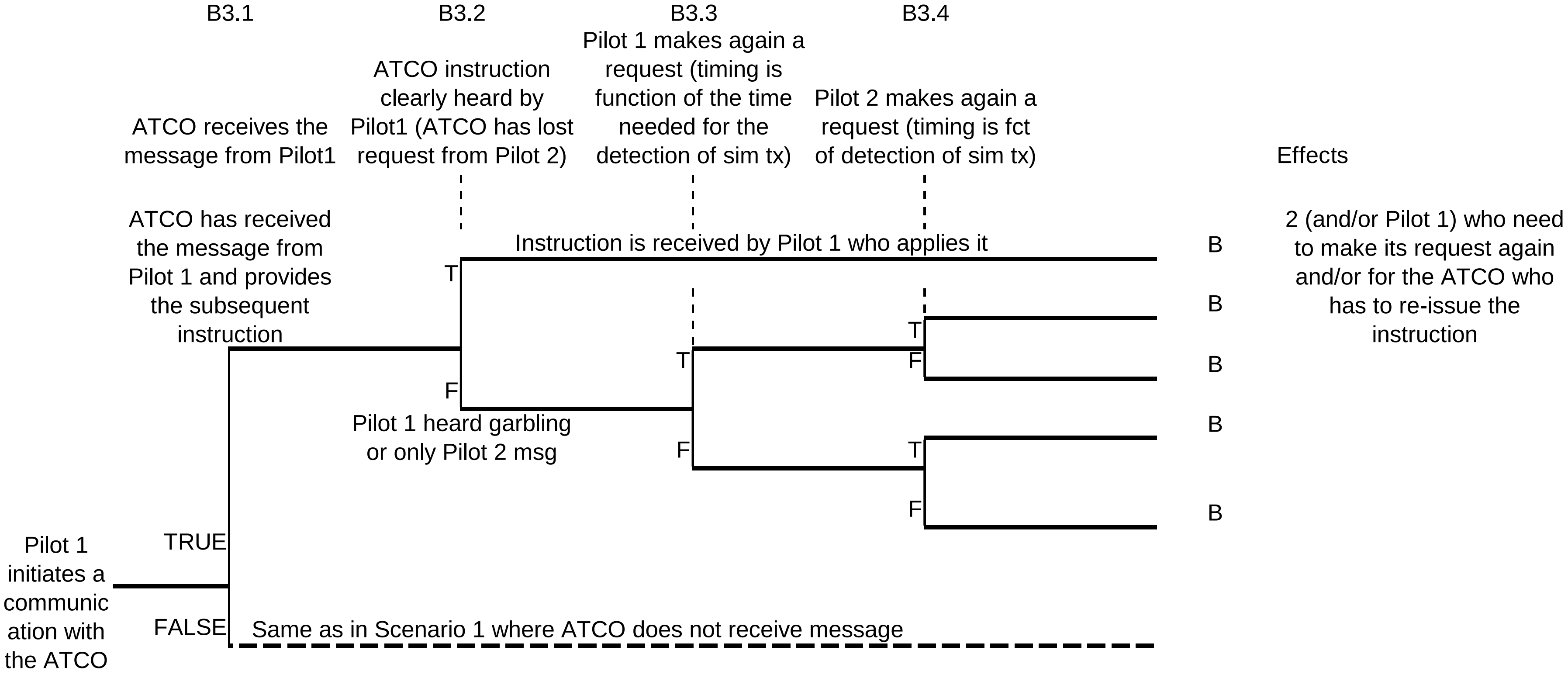

Figure 15: Event Tree - Scenario 3

3.3.3.1 Barrier B3.1 – ATCO receives the message from Pilot 1

More than a barrier, this is the imitating event. Pilot 1 has initiated the communication by making a request to the ATCO. As the ATCO answers, Pilot 2 tries to use the frequency simultaneously.

3.3.3.2 Barrier B3.2 - ATCO instruction clearly heard by Pilot1

Pilot 1 would receive:

- only one of the 2 messages, based on the relative strengths and distances between transmitters and receivers, pure physics laws
    - o the instruction by the ATCO
        - Pilot 1 would r/b and apply the instruction
        - ATCO might not have received the message from Pilot 2:
            - if the message is a request, Pilot 2 will most probably re-issue the request
            - if the message is a r/b to a previous instruction, see Scenario 1

            NB: it is understood that only in peculiar circumstances would the ATCO issue successive instructions to different a/c before receiving r/b.
    - o the request from the 2nd aircraft (Pilot 2)
        - the receiver onboard the 1st a/c suppressing/not able to detect (laws of Physics) the signal coming from the ATCO. This would happen when the signal from the 2nd a/c is stronger (>8dB) than the one from the ground, if the a/c are relatively close to each other (closer than the ground station), depending also on the types of antenna (on the ground and on the a/c), the (noisy) environment of pilot 1…
- garbling: difference of strength between the 2 signals is <8dB, both are presented to Pilot 1.
- partial overlap: the weakest (suppressed) signal has to last, in function of the system architecture, 0,5 to 1s (in coupled frequencies situation) more than the other.

3.3.3.3 Barrier B3.3 – Pilot 1 makes again the request and Barrier B3.4 - Pilot 2 makes again the request

It is understood that pilots will re-issue their requests after a period of time (shorter if the situation is detected).

ANNEX 1 – Points of Contact

This annex presents the points of contact of the different Organizations involved in this initiative.

Organization	Name	Email address
AUSTROCONTROL	Rudolf KERN	rudolf.kern@austrocontrol.at
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NAVIAIR	Dan Dreijer ANDERSEN	dda@naviair.dk
SKYGUIDE	Roger SUTER	roger.suter@skyguide.ch

Table 2: Points of contact

ANNEX 2 – Cross-coupling modes of operation

In its Annex D, ED136 provides an explanation on cross-coupling modes of operation.
The following sub-sections are extracts from ED136.

A2.1 The Cross-Coupled Group

Two or more frequencies MAY be assigned to an individual Cross-Coupled Group. A Cross-Coupled Group MAY consist of both Simplex Mode and Duplex Mode frequencies.

A2.2 Frequencies Received at a Controller Working Position (CWP)

When two or more frequencies are received, the first frequency to be received and detected by the Voice Communication System (VCS) is presented at the CWP the other(s) being suppressed.

In the extremely unlikely event of two or more frequencies being received, simultaneously, only one frequency is presented at the CWP. The determination of which frequency is presented to the CWP is ANSP/VCS specific and thus outside the scope of this Information Paper.

A2.3 Re-Transmission of Received Frequencies

A2.3.1 Simplex Mode[3]

Received frequencies in Simplex Mode are never re-transmitted on other frequencies in the Cross-Coupled Group.

A2.3.2 Duplex Mode

All received frequencies in Duplex Mode MAY be re-transmitted on all the other frequencies in the Cross-Coupled Group - but only one at a time. The received frequency re-transmitted is always presented at the CWP.

[3] In the context of Undetected Simultaneous Transmissions, the Simplex mode is considered as single channel operations from the point of view of ATC-pilot communication.

Mode	**Description / Illustration**	**What is heard by the controller**
Duplex / Symmetrical (most common Mode)	Pre-Configuration a) Frequency F1d is cross-coupled with Frequencies F2d and F3d in a cross-coupled group. All frequencies are configured as ‘Duplex’ Mode of Operation a) Reception on F1d will be re-transmitted on F2d and F3d. b) Reception on F2d will be re-transmitted on F1d and F3d. c) Reception on F3d will be re-transmitted on F1d and F2d. This mode would be used, for example, when Sectors are combined to be controlled from a single position.	a) Only reception on F1d is sent to the controller (to avoid echo) b) Only reception on F2d is sent to the controller (to avoid echo) c) Only reception on F3d is sent to the controller (to avoid echo)

Mode	Description / Illustration	What is heard by the controller
Simplex / Asymmetrical	Pre-Configuration a) Frequency F1d is cross-coupled with Frequencies F2d and F3s in a cross-coupled group. b) Frequencies F1d and F2d are configured as 'Duplex' c) Frequency F3s is configured as 'Simplex'. Mode of Operation a) Reception of F1d is re-transmitted on F2d and F3s. b) Reception on F2d is re-transmitted on F1d and F3s. c) Reception on F3s is NOT re-transmitted. This mode would be used, for example, when a Tower frequency (VHF) is re-transmitted on a Ground Mobile frequency (UHF) so that mobiles MAY be aware of aircraft manoeuvres in progress and intended. Another application would be the retransmission of a Civil Frequency on a Military Frequency but not the other way round.	a) Only reception on F1d is sent to the controller (to avoid echo) b) Only reception on F2d is sent to the controller (to avoid echo) c) Reception on F3s will be presented to the controller (but only if either F1d or F2d are not received first –Refer to "Cross-Coupling Combinations following).

Table 3: Illustration of cross-coupling modes functionality (from ED136)

A2.3.3 Cross-Coupling Combinations

<u>Pre-Configuration</u>: Frequencies F1d, F2d and F3s are in a Cross-Coupled Group. F1d and F2d are in Duplex Mode. F3s is in Simplex Mode.

Active Frequencies Due to a/c transmissions			What is heard at the CWP	What is retransmitted
F1d (1st received)	F2d	F3s		
0	0	0	Silence	Nothing
0	0	1	F3s	Nothing
0	1	0	F2d	F2d on F1d and F3s
0	1	1	F2d	F2d on F1d and F3s
1	0	0	F1d	F1d on F2d and F3s
1	0	1	F1d	F1d on F2d and F3s
1	1	0	F1d	F1d on F2d and F3s
1	1	1	F1d	F1d on F2d and F3s

Table 4: cross-coupling combinations- frequency f1d received first

Active Frequencies Due to a/c transmissions			What is heard at the CWP	What is retransmitted
F1d	F2d	F3s (1st received)		
0	0	0	Silence	Nothing
0	0	1	F3s	Nothing
0	1	0	F2d	F2d on F1d and F3s
0	1	1	F2d and F3s	Nothing
1	0	0	F1d	F1d on F2d and F3s
1	0	1	F1d and F3s	Nothing
1	1	0	F1d or F2d depending on 1st one detected	Either F1d on F2d and F3s or F2d on F1d and F3s (depending upon 1st received)
1	1	1	Specific to ANSP/VCS	Nothing

Table 5: cross-coupling combinations- frequency f3s received first

ANNEX 3 –Call Sign Similarity

Similar sounding ATC call signs (e.g BAW 223 and BAW 243) can induce, inter alia, incidences of simultaneous transmissions by pilots. A EUROCONTROL project is underway to introduce solutions that will reduce the incidence of call sign similarity (CSS) events (including Simultaneous Transmissions) and thus improve operational safety levels.

The main solution is based around the development of a call sign similarity tool (CSS Tool) that will be able to detect and then de-conflict similar call signs within aircraft operators' schedules of flights. In addition, a Call Sign Management Cell (CSMC) has been established in the CFMU to provide a centralized Call Sign Similarity Service, e.g providing management and advice and guidance on the use of the CSS Tool. The initial development and deployment of the CSS Tool is expected in Autumn 2011 but it will be constrained by the following caveats:

- The initial use of the CSS Tool will be **limited to single aircraft operator's schedules only** in **advance** of the IATA Winter or Summer season , i.e. the Tool **will not detect and de-conflict** similar call signs **between aircraft operators**.
- The CSS Tool will support 'scheduled' operations more readily than say 'business' or 'cargo' operations that are conducted on a more random basis - the Tool **will not support ad hoc**, day-to-day changes of call signs in the schedules, i.e **during** the IATA Winter or Summer Season.
- The CSS Tool will address the suffix part of the ATC Call Sign/Flight Identifier, i.e. it will not be concerned with the ICAO Aircraft Operator Designator (e.g. AFR) part of the flight identifier.

Note: Depending on the success of the first version of the Tool/Service and available resources, further developments of the CSS Tool/service may take place to enable cross-checking of call signs between aircraft operators and, perhaps, also to support ad hoc call sign similarity operations during the IATA season.

For more details, please refer to the Call Sign Similarity Briefing Note No2 (taken from the AGC Action Plan) which lists the potential effects of Call Sign Similarity/Confusion:

http://www.skybrary.aero/bookshelf/books/114.pdf.

"The danger of an aircraft taking and acting on a clearance intended for another is obvious. The following are some of the potential outcomes of such a situation:

(a) the aircraft takes up a heading or routing intended for another;

(b) the aircraft commences a climb or descent to a level to which it has not been cleared;

(c) the aircraft leaves the appropriate RTF frequency;

(d) in responding to a message, the aircraft blocks a transmission from the intended recipient;

(e) the intended recipient does not receive the clearance, and fails to take up the desired heading or routing, or fails to climb or descent to the cleared level;

(f) the controller misunderstands the intentions of aircraft under his/her control;

(g) the controller issues a clearance to the wrong aircraft, and/or fails to issue a clearance to the intended aircraft;

(h) the workload of controllers and pilots is increased because of the necessity to resolve the confusion.

Similar info is also described in the Call Sign Confusion article on SKYbrary at http://www.skybrary.aero/index.php/Call-sign_Confusion

ANNEX 4 – Data Analysis

A4.1 Objective

A qualitative look at the data available would lead to a better understanding of:

- How often and when does USiT occur?
- In which environments is it more prevalent?
- What consequences does it have on ATM?
- How much of a risk does it represent in relation to other ATM risks?
- What factors affect the impacts of USiT?

A4.2 SAF-LEARN Incident data 1998-2003

A4.2.1 About SAF-LEARN Data

From 1998 till 2003, SAF-LEARN has gathered detailed incident data (investigation results) from 6 ANSP (Maastricht, NATS, DFS, Skyguide, ENAV, DSNA) representative for dense traffic operations.

As shown in Table 6, it presents 420 Incidents (397 Separation Infringements, 23 Incursions) for En-Route, TMA and Airport Operations.

As transcripts of RT data are available, it has been possible to elucidate USiT events.

However some limitations exist for the use of this set of data:

- The data is not complete for the period and therefore can only be used for qualitative analysis.
- The data is from a period before the technology of BSS was available

	En-Route	TMA	Airport	Total
Separation Losses	211	186	23	420
Risk Cat. A	16	35	2	53
Risk Cat. B	70	100	8	178
Risk Cat. C	108	44	10	162
Risk Cat. D	17	7	3	27
Risk Cat. E	-	-	-	-

Table 6: SAF-LEARN Data

A4.2.2 SAF-LEARN Data and USiT

In further analyzing the SAF-LEARN data, it was possible to identify that 15 cases out of 420 occurrences involved USiT (14 losses of separation and one runway incursion)

- 10 causal factors being a direct trigger to the eventual loss of separation
- 5 contributing factors to the occurrence in delaying or preventing resolution of a conflict.

Table 7 shows that 7 of those occurrences happened in En-Route and TMA Operations and one in Airport Operations.

The involvement of USiT in incidents in both En-Route and TMA is similar at about 3.3-3.5%. USiT in TMA has three times the higher risk consequences in comparison to En-Route. UST in En-Route creates more conflicts but in TMA it has a much higher impact on conflict resolution.

In addition, it is worth noting that:

- 9 Cases were A/B risk and of these 2 were in En-Route, 6 in TMA and one in Airport Operations.
- Callsign confusion was a factor in 2/15 cases (13%) - one was cat.A
- High workload was a factor in 3/15 cases (20%) - two were cat.A

	En-Route	**TMA**	**Airport**	**Total**
Occurrences	211	186	23	420
USiT Cases	7	7	1	15
Involvement	3.3%	3.5%	4.5%	3.6%
Causal	3%	2.5%	0%*	2.4%
High Risk A/B	1%	3%	4.5%	2.1%
Created Conflict	3%	2%	0%*	2.4%
Prevented Resolution	0.5%	1%	4.5%	0.9%
Prevented Collision Avoid.	0%	0.5%	0%*	0.2%

Table 7: USiT in SAF-LEARN Data

Further analysis of the data showed that, in the 10 created (Induced) conflicts:

- 3 due to blocked readback of incorrectly understood instructions leading to unexpected maneuvers. (1ER/2TMA)
- 4 due to the wrong aircraft taking an instruction due to USiT. In 3 cases bad readback was missed and one had no readback. (3ER/1TMA)
- 3 due to blocked instruction to resolve future conflict [no readback].(2 ER/1TMA)

Of the remaining 5 cases

- 4 were failures of conflict resolution and 1 was a failure of collision avoidance (after LOS). 3/5 of these were TMA cases.
- In 3 cases the problem was delay (confusion/reissue of instruction). 2 of these were detected by readback.
- Remaining cases (2) the resolution was prevented.

A4.2.3 USiT vs other ATM Risks

Table 8 shows a comparison between the different hazards/ATM risks sources. One can see that, according to these data, Simultaneous transmissions presents the equivalent ATM Risk as Call Sign Similarity/Confusion.

SAFLEARN: Ranking of Hazards.	**Involved**	**Causal**	**CAT A-B**
Controller Separation Misjudgement	17.0%	15.4%	12.9%
Pilot Level Busts (leading to LOS)	14.8%	13.9%	9.6%
High Controller Workload	11.5%	0.5%	6.7%
Failure to detect conflict	11.2%	9.1%	3.1%
Airspace Penetration (leading to LOS)	7.7%	7.7%	4.1%
Failure of hearback / readback	6.7%	1.9%	1.5%
ATCO Phraseology	3.8%	0.5%	0.2%
Simultaneous Transmissions	**3.5%**	**2.4% (2.9% in En-Route)**	**1.9% (3.4% in TMA)**
Callsign Confusion (in LOS)	3.3%	2.4%	2.2%
Bad Transfer of a/c	2.9%	1.0%	0.5%

Table 8: USiT (SAF-LEARN) vs other ATM Risks

A4.3 ANSP Safety Data 2005-2007

A4.3.1 About ANSP Safety Data

Major ANSP have provided a set of Safety factors for a 3 years period. This represents 5714 voluntary reports and 688 mandatory reports (71 airprox and 617 losses of separation) for En-Route and TMA operations.

Limitations of this set of data are:

- UST events have to be mapped onto these safety factors so some subjectivity was involved. Different experts created the data for each year.
- Voluntary reports are a subset of events and vary according to the emphasis on particular problems. A Level bust campaign in 2005 had a big impact on reporting of all safety events linked to that problem. This leads to bias which limits the use of these 5714 occurrences for detailed quantitative assessment.
- Full reports not available (only factors) so relies upon ANSP evaluation of each event. Cannot investigate each event for a better understanding.

	2005 Enroute	**2006 Enroute**	**2007 Enroute**	**2005 TMA**	**2006 TMA**	**2007 TMA**
Flight Hours	**520,000**	**535,000**	**545,000**	**225,000**	**235,000**	**240,000**
Total Sample	1.6M flight hours			0.7M flight hours		
Airprox	3	4	8	21	19	16
Separation Loss	56	48	40	136	182	155
External	n/a	41	40	n/a	10	10
Occurrences	1000	1021	1044	765	949	935
Overload	25	33	25	4	2	4
Total	***1084***	***1147***	***1157***	***926***	***1162***	***1120***

Table 9: ANSP Safety Data

A4.3.2 ANSP Safety Data and USiT

As this set of ANSP data is built out of different causal and contributory factors, some work has been required to map those to USiT.

This mapping has been performed based on the following criteria:

- RT-Call Blocking
- ATC/Pilot Communications -Ambiguous Transmission (Garbled)
- RT-Call Swamping (Lost message)
- ATC/Pilot Communications – Frequency Congestion
- RT-Frequency Coupling (Lost data)
- RT-Interference (Garbling)

For the TMA Environment (473 SI)

- 14 SI involved UST (3%) – SAFLEARN gave 3.5%
- 7 SI were caused primarily by UST (1.5%) – SAFLEARN gave 2.5%

For the Enroute Environment (144 SI)

- 3 SI involved UST (2%) – SAFLEARN gave 3.3%
- 1 SI was caused primarily by UST (0.7%) – SAFLEARN gave 3%

A4.3.3 USiT vs other ATM Risks

This information should be considered for information only as:

- There was insufficient data to make any trend analysis for the 2005-2007 data. Hence they were used together for a 3 year period.
- The Enroute data has very few USiT factors.
  - On close examination it seems that in pilot induced conflicts the En-Route investigator did not consider any communications issues. SAFLEARN shows that about 10% of these have involvement of USiT.
  - Safety factors were not determined once a non ATC cause was established. Since we do not have access to the full reports this cannot be corrected.
- Reporting inconsistency found in the data associated with occurrence data other than Airprox/Loss of separation (such as that causing Level bust).
  NB: This is typical of voluntary data collection. No quantitative use could be made of this data since the content varied year by year with campaigns for different information collection.

Table 10 shows a comparison between the different hazards/ATM risks sources. Based on the above mentioned limitations, no clear conclusion can be made of this set of data.

ANSP Data	**ENROUTE**		**TMA**	
HAZARD INVOLVED IN SEPARATION INFRINGEMENTS	**Number of Occurrences**	**Occ / fh (based on 1,6Mfh)**	**Number of Occurrences**	**Occ / fh (based on 0.7Mfh)**
Total occurrences	**144**	**9.0E-05**	**473**	**6.7E-04**
UST Involvement separation loss	**3**	**1.8E-06**	**14**	**2.5E-05**
UST Causal in separation loss	**1**	**6.0E-07**	**7**	**1.2E-05**
ATCO Misjudgement of Separation	9	5.6E-06	33	1.2E-05
ATCO Fails to detect conflict	32	2.0E-05	76	1.1E-04
ATCO Loss of awareness	2	1.2E-06	7	1.2E-05
Pilot Lateral Deviation	9	5.6E-06	7	1.2E-05
Radio Failure	1	6.0E-07	2	2.8E-06

ANSP Data	**ENROUTE**		**TMA**	
HAZARD INVOLVED IN SEPARATION INFRINGEMENTS	**Number of Occurrences**	**Occ / fh (based on 1,6Mfh)**	**Number of Occurrences**	**Occ / fh (based on 0.7Mfh)**
Inadequate Pilot Response	10	6.0E-06	41	5.9E-05
ATCO inadequate communications	8	4.9E-06	10	1.4E-05
Airspace Infringement causes LOS	15	9.0E-06	178	2.6E-04
Level bust causes LOS	25	1.5E-05	72	9.2E-04

Table 10: USiT (ANSP Safety Data) vs other ATM Risks

REFERENCES

GLOSSARY

ABBREVIATIONS