INTEROPERABILITY ISSUES BETWEEN RECOGNISED GMDSS MOBILE SATELLITE SYSTEMS
Impact on MSI providers and RCCs
(agenda 3.3.5)

Submitted by the International Mobile Satellite Organization

SUMMARY

Executive Summary:	This document provides the outcome of IMSO's study on the Interoperability issues and their impact on the MSI providers and the RCCs
Action to be taken:	Paragraph 4
Related documents:	COMSAR 4/13, COMSAR 4/14, NCSR 1/12/1, NCSR 1/12/2, NCSR1/28, NCSR 2/8, NCSR 2/9/2, NCSR 3/14, NCSR 3/29, NCSR 4/12, NCSR 4/29, MSC 92/26, MSC 94/9/3, MSC 99/12/1, IMO/ITU EG 10/4/1, IMO/ITU EG 11/4/2, COMSAR/Circ.37, MSC.1/Circ.1414, Resolution MSC.451(99), Resolution A.705(17), Resolution A.706(17), Resolution A.707(17), and Resolution .1001(25)

1. Background

1.1 Interoperability has been a subject matter of discussion at various international bodies including the IMO Maritime Safety Committee (MSC) and the Sub-Committee on Navigation, Communication and Search and Rescue (NCSR), the IHO WWNWSC, and the IMO/ITU Joint Experts Group, ever since the application for the Iridium satellite system to be recognized as a Global Maritime Distress and Safety System (GMDSS) service provider was made formally in 2013. Questions were raised as to how the operation of additional provider would affect the provisioning of Maritime Safety Information (MSI) and Search and Rescue (SAR) messages.

1.2 The discussions and outcomes were not conclusive on the real consequences of the Iridium recognition to MSI providers and Rescue Co-ordination Centres (RCC). Even after some years of discussion, the said interoperability problem is still not well defined, let alone resolved. This lack of established measures may lead to an inefficient handling of the situation under multiple providers engaged in the satellite communication services for GMDSS.

1.3 IMSO, with its public safety interest in mobile satellite communications for the GMDSS, have been following the issue, since it could affect the Organisation's mission of overseeing the providers and has carried out a comprehensive analysis of the issues involved.

1.4 IMSO's study on the Interoperability issues and their impact on the MSI providers and the RCCs has been articulated under the titles:

.1 Operational and financial impact on MSI providers and RCCs as set out in annex 1; and
.2 Concept of Single Point of Distribution System, as set out in annex 2.

2. Discussion

2.1 It is noted that the inclusion of new a satellite service provider is acknowledged to be beneficial to the maritime community in the long term. However, The negative impacts are foreseen for the MSI providers and RCCs. These are the groups that ensure the safety of life at sea with timely and highly significant information. Moreover, MSI providers have, for years, carried by themselves, the burden of the costs involved. It is therefore essential to seek a solution to minimise the burden of costs and, at the same time, ensures that the global performance of EGC transmissions from shore to ship is not compromised.

2.2 In conducting its study IMSO has taken into account the comments and concerns raised in various international fora on the operational and financial impacts on the MSI providers and the RCCs and analysed them under the Annex 1. Based on the outcome of the analysis a situation summary has been presented under Section 4, Table 1. Furthermore, considering the information under analyses, the challenge related to Interoperability has been identified as:

> ***"Mitigation of the negative operational and financial impacts on the MSI providers and the RCCs, as a result of the incorporation of new communication satellite service providers and, at the same time, ensure the global performance of EGC transmission from shore to ship is not adversely affected"***

2.3 The IMSO study has also focused on the current approaches towards solutions and possible outcomes, as presented under the annex 1, paragraph 5. Having considered the background and the negative impacts that are still likely to prevail under the first two options (annex 1, paragraphs 5.1 and 5.2), IMSO decided to give further internal consideration to the 'Single Point of Distribution' approach under paragraph 5.3, in order to evaluate its feasibility and possible effects on the GMDSS.

2.4 A high-level architecture was designed, benefiting from industry standards and the previous experience with the Long-Range Identification and Tracking of Ships (LRIT) system. This architecture has been developed considering the need for a light and resilient operational system, as presented in the annex 2.

2.5 The important features of the draft architecture are:

- after implementation, the incorporation of new service providers, will cause no operational impacts on the MSI providers and SAR service;
- the solution presents a new paradigm for monitoring. The service providers will be responsible for ensuring the receipt and the broadcast of MSI and SAR messages, according to the instructions provided by the originators. These notifications will be transmitted to the single point of distribution which will forward this information to the MSI or SAR message originator. The system will present to the MSI providers

and RCCs, in a single interface the original message the follow-up information in a way that the operator could easily notice an anomaly;

- it was devised as a process to ensure the provision of the MSI information and SAR messages to satellite service providers in the event of failure of the single point of distribution, with two levels of operation. The architecture also considered the recovery process to normal operation:
    - In the case that the software used by RCCs and MSI providers fails for some unknown reason, they would be able to use a web interface to access the single point of contact system; and
    - The last resource for RCC and MSI providers is accessing a web interface in each service provider.
- the suggested contingency procedure is much less expensive than external solutions but requires some control, along with drills and exercises of to test the contingency measures.
- the single point of distribution records all MSI and SAR messages and follow-up information in a historical data warehouse. This data warehouse is devised as a tool for external control and provides transparency on the system operation; and
- the architecture is scalable and devised in a way it could easily exchange information with other systems. In any future need, it could be used to transmit distress messages or as an integration point between GMDSS and GADSS.

3. Conclusion

3.1 Having considered the issue of Interoperability, in the context of incorporation of new satellite service providers in the GMDSS, it appears that, the scope of minimisation of operational impacts is limited for the shore-to-ship path of MSI providers and RCCs.

3.2 Also, having assessed the approaches already under discussion, the approach of using a single point of distribution has been explored in depth, along with a possible architecture. This architecture includes some relevant features such as the support for monitoring transmissions and disaster recovery procedures. It takes into account almost all the concerns presented in the background information.

3.3 IMSO is aware that no option is complete at this stage, and that further study and discussions are needed. However, it is noted that, considering the problem and the current approaches, the issue is better addressed by the single point of distribution approach, unless other solutions can be found that are more favourable.

4. Action requested of the Sub-Committee

The Sub-Committee is invited to note the information provided and consider them as it deems appropriate.

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ANNEX 1

Operational and financial impacts on the MSI providers and the MRCCs

1. Background

1.1 The document COMSAR 4/13, from Australia, on Iridium and other Satellite Telecommunications Companies, firstly raised the issue, in 1999. The document discussed the likelihood of new satellite service providers carrying SAR information and the potential consequences to RCCs. It noted that RCCs could be confounded by a multiplicity of individual arrangements and boundaries, highlighting that these new arrangements could not align to the search and rescue regions. The document suggested that IMO, together with the Member States, would take a proactive role in liaising with companies to make them aware of existing IMO arrangements for SAR and that IMO would be able to assess the potential for inclusion in the GMDSS. COMSAR 4 noted this information in its report to the MSC (COMSAR 4/14).

1.2 In 2008, IMSO informed COMSAR 12 that only Iridium and Inmarsat answered an invitation to discuss the provision of MSI in Arctic regions. On that occasion Iridium informed its intention to apply for its recognition as a GMDSS service provider pursuant to the IMO Resolution A.1001(25).

1.3 In 2013, MSC 92 received an application for recognition of Iridium as an additional satellite service provider in the GMDSS. MSC 92 instructed the NCSR Sub-Committee to conduct the assessment under the agenda item "Developments in maritime radiocommunications systems and technologies" (MSC 92/26, paragraphs 9.22 to 9.25).

1.4 NCSR 1 in 2014, considered the Iridium application made on its behalf by the United States under document NCSR 1/12. This document presented some actions Iridium had taken about MSI provision and RCC support. The description of how Iridium intended to liaise with RCCs and MSI providers was similar to the existing arrangement between those and Inmarsat. The document did not consider interoperability issues and possible negative consequences to MSI providers and RCCs but suggested that the Sub-Committee should invite International Hydrographic Organization (IHO) and World Meteorological Organization (WMO) to provide advice about the shore-to-ship broadcasting of MSI. The issue had no definite links to the regulations in place at that time, nor to resolution A.1001(25); thus, Iridium was not expected to discuss interoperability in its original application.

1.5 At NCSR 1, IMSO also, presented the document NCSR 1/12/1 discussing the recognition process, highlighting the possible need to involve Maritime Rescue Co-ordination Centres (MRCC) and/or MSI providers. The document NCSR 1/12/2 from the United Kingdom presented some issues to be clarified about the application for recognition by Iridium, but these issues did not include interoperability. However, during the ensuing discussion in NCSR 1, some delegations expressed concerns related to possible additional requirements, equipment and associated costs to SAR authorities, RCC and MSI providers, as reflected in the NCSR 1 report (NCSR1/28).

1.6 At MSC 94, in November 2014, the United States submitted the document MSC 94/9/3 which discussed concerns related to interoperability raised by Member States during NCSR 1 (NCSR 1/28). The document presented the GMDSS as a "system of systems" with "elements and procedures". Additionally, it spoke about the concept of 'indirect interoperability', since many of the GMDSS elements are incompatible with each other and noted that the International Aeronautical and Maritime Search and Rescue (IAMSAR) manual also recognises indirect interoperability. The document also stated that there is no need for RCCs and MSI providers to install Iridium terminals for sending or receiving information/messages. However, it stated further that MSI providers may choose to install a terminal to monitor their transmissions. The document ultimately suggested that MSI providers could pay in a fixed annual charge as solution.

1.7 At NCSR 2 in 2014, France and Spain presented the document NCSR 2/8, raising similar concerns to those discussed at NCSR 1, arguing that interoperability and possible additional requirements for SAR authorities and RCCs as a consequence of Iridium's recognition had not been satisfactorily addressed or solved in both in NCSR1 and MCS 94.

1.8 France and Spain also presented the document NCSR 2/9/2 highlighting the need to consider interoperability, operational problems and the operating costs associated with the use of additional mobile satellite communication systems in the GMDSS. The document also discussed the operational and financial impact and suggested that operators of mobile satellite communication providers should consider and submit proposals, in order to ensure that there is no increase in the costs associated with the provisioning of MSI.

1.9 The report of NCSR 2 to the MSC consolidated the plenary discussions and referred the interoperability issue to the 'Correspondence Group on the Review of the GMDSS', which was instructed to develop proposals including the consideration of the costs associated with recognition of additional GMDSS satellite service providers (NCSR 2/23, paragraph 9.18.1.1).

1.10 The recognition process for the Iridium system followed resolution A.1001(25) and MSC.1/Circ.1414, neither of which includes provisions related to interoperability.

1.11 The Correspondence Group presented its report in document NCSR 3/14. The paragraph 2.2 of the annex 1 to the document refers to interoperability as "the ability to conduct ship-to-ship, ship-to-shore, and shore-to-ship communications without regard to differing satellite systems in use by the communicating stations". The use of Public Switched Telephone Network (PSTN) to achieve this was also presented.

1.12 The correspondence group on the Review of the GMDSS, also considered costs implications as a consequence of the approval of additional GMDSS satellite service providers. The group expressed the view that charges for MSI broadcasts should receive further consideration in the context of revising resolution A.707(17), such that no charges would be invoiced to the originator. It was also noted that MSI providers use ship earth station terminals to monitor the broadcast of MSI, but no need was identified for installing terminals in RCCs. They also considered the need to standardize ECG messages, the use of a single point of distribution and the need of new approaches to monitor the MSI broadcast.

1.13 The NCSR3 re-established the Correspondence Group on the Review of the GMDSS. The correspondence group report was submitted in the document NCSR 4/12, from the

United States. This document included the Draft Modernization Plan of the GMDSS. The NCSR 4 considered the report and forward it to the MSC (NCSR 4/29, annex 11).

1.14 The MSC 98 approved the Modernization Plan of the GMDSS (MSC 98/23, paragraph 12.1). The Modernization Plan included outcomes related to the interoperability in its topic "Provision of GMDSS satellite services and redefinition of Sea Area A3", paragraphs 29 to 32. Some relevant paragraphs are reproduced below for ready reference:

> *"29 Formatting of Enhanced Group Calling (EGC) should be standardized for the MSI Provider and SAR authority message originator to be the same irrespective of the satellite provider if possible to minimize delays (Detailed review paragraph 17.35). The Joint IMO/IHO/WMO MSI Manual provides guidance on standardization and harmonization of the format of MSI messages. The IAMSAR Manual, Volume II, provides guidance to SAR operators for formatting SAR related EGC. The International SafetyNET Manual includes coding which must be followed for preparing SafetyNET broadcasts, including SAR broadcasts. It is concluded that no further work is needed on standardized operational formatting. However, there will be a need in the near future for a standardized EGC adapted to a digital format."*
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> *"30 If possible, a way should be found to transmit EGC simultaneously on all GMDSS satellite service providers (Detailed review paragraph 17.35). A solution suggested by the ICAO/IMO JWG on SAR (IMO/ITU EG 11/4/2), is to transmit EGC messages through one single point of distribution where message originators (MSI providers and SAR operators) would deliver their messages. Those messages would then be forwarded to satellite service providers for broadcasting through their respective network. Remaining questions are, among others, who would operate, maintain and finance such a single point of distribution?"*
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> *"31 Possible ways for MSI providers to provide and monitor MSI broadcasts over multiple GMDSS satellite service providers should be identified with a view to minimizing or not increasing the cost for MSI providers. Resolution A.707(17) could be revised to provide for shore-to-ship MSI broadcasts without charge to the originator (Detailed review paragraph 17.36). Originators (MSI providers and SAR operators) are required to monitor the broadcast of their messages by every satellite service provider and would experience increased costs if separate receivers were needed for this purpose. Recommendation ITU-T D.90 [1] on Charging, billing, international accounting and settlement in the maritime services is of interest to the GMDSS satellite service providers as it lists the types of maritime communications for which no charges were raised and is in alignment with the IMO requirements in resolution A.707(17)."*
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> *"32 The GMDSS Master Plan needs to be revised and an MSI manual or manuals prepared to include additional satellite service providers (Detailed review paragraph 3.22; partly paragraph 3.10). MSI manuals are now specific to the satellite service provider but should be combined into a single generic manual. Both actions can be completed under the NCSR continuing work item on updating of the GMDSS master plan and Guidelines on MSI (maritime safety information) provisions."*

[1] NB: Recommendation ITU-T D.90 carries forward the charging exemptions first instituted by ITU in the Additional Regulations annexed to the International Radiotelegraph Convention (Washington) of 1927

1.15 NCSR 5 appreciated the work done towards the recognition of Iridium as a GMDSS satellite provider, but without consensus, and the Maritime Safety Committee was therefore requested to provide further guidance (NCSR 5/23, paragraph 14.55).

1.16 After considering the issue, the MSC 99 adopted the resolution MSC.451(99), related to the Statement of Recognition of the Maritime Mobile Satellite Services to be provided by Iridium Satellite LLC. MSC99 also recognized that some outstanding issues remained regarding the implementation GMDSS services by Iridium and invited IMSO to monitor the implementation of these issues and report back to MSC once a satisfactory conclusion had been reached. These remaining outstanding issues do not include interoperability concerns.

1.17 In the same MSC session, the Committee considered document MSC 99/12/1 (China), which presented the application of the BeiDou Message Service System for recognition and use in GMDSS. The Committee referred the application to the NCSR and authorised the Sub-Committee to invite IMSO to conduct the Technical and Operational Assessment, as appropriate. The potential recognition of BeiDou may lead to a more complex scenario for MSI providers and RCCs.

2. Current regulatory framework related to MSI and SAR messages provision

2.1 To consider the issue, it is first necessary to define the existing problem and its boundaries. Careful observation shows that interoperability has been specifically discussed from the perspective of MSI providers, RCCs and SAR authorities. The current regulatory framework must therefore be considered:

2.2 The workings of the Word-Wide Navigational Warning Service are set out in resolution A.706(17), as amended. The consolidated text is published in the MSC.1/Circ.1288/Rev.1. The resolution requires that the NAVAREA Coordinator, the Sub-area Coordinator, and The National Coordinator must monitor the broadcasts originated by them in order to ensure that the warnings have been correctly broadcast (paragraphs 6.2.1.11, 6.4.1.11, and 6.6.1.11)

2.3 The Revised International SafetyNet Manual, edition 2018, published in the MSC.1/Circ.1364/Rev.1, provides the procedure for monitoring the MSI transmissions in paragraph 9:

- *To ensure the integrity of the MSI being broadcast, MSI providers must monitor the broadcasts which they originate in accordance with resolution A.706(17), as amended. Monitoring is especially important in a highly automated system, which is dependent on careful adherence to procedure and format. This shall be accomplished by the installation of an Inmarsat C or mini-C terminal with EGC SafetyNET receiver to enable each MSI provider to:*
    1. *confirm that the message is transmitted and received correctly;*
    2. *ensure that cancellation messages are properly executed; and*
    3. *observe any unexplained delay in the message being broadcast.*
- *EGC receivers only display or print messages on the first occasion they are received. Therefore, in order for MSI providers to confirm that all messages in force are still*

being transmitted by the LES, and that cancelled messages are no longer being transmitted, the EGC receiver used by the MSI provider to monitor their SafetyNET broadcasts should be powered down (including the transceiver), and re-booted at regular intervals, wherever this is possible. Alternatively, MSI providers should consult their equipment supplier for specialist EGC monitoring software which would not require the MES to be re-booted.

2.4 Resolution A.705(17) on Promulgation of Maritime Safety Information presents the information flow for MSI (see Figure 1 there in and reproduced below). It shows that although SAR information is not a type of MSI, it shares the same communication infrastructure and flow. MRCCs therefore have some priority for specific communications.

2.5 It is also noted that, according to Resolution A.707(17), in the shore-to-ship communication path, only the following messages are free of charge to the originator:

- Distress messages;
- SAR Coordination; and
- Medical advice/assistance.

2.6 Furthermore, the Guidance on Minimum Communications Needs of Maritime Rescue Coordination Centres (MRCCs), COMSAR/Circ.37, presents the following:

"In terms of communications, an MRCC should be capable of receiving information from (and transmitting information to) anybody or person concerned, including in the form of maritime safety information (MSI) (paragraph 1.2.1.4). Depending on the areas involved MSI is transmitted via the International SafetyNET.

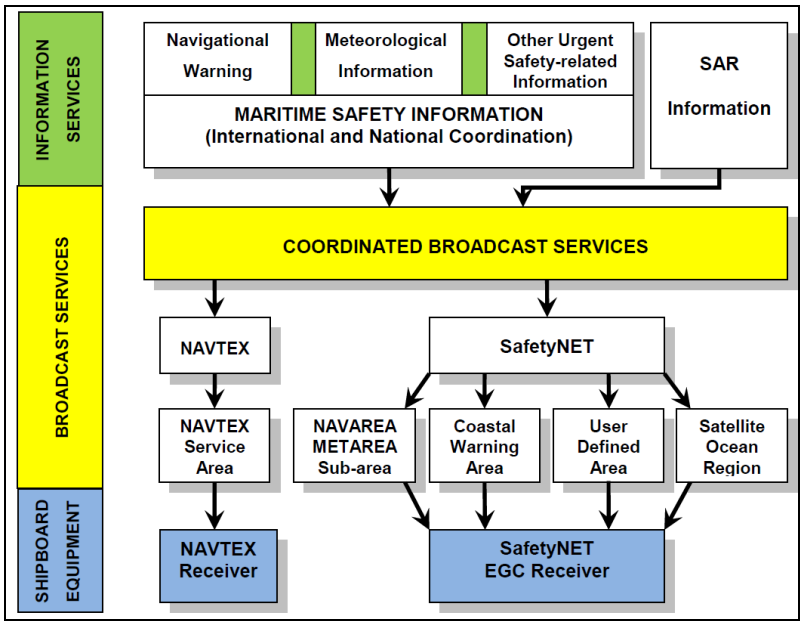

Figure 1- The maritime safety information service of the Global Maritime Distress and Safety System (from Resolution A.705(17), as amended

MRCCs that originate SafetyNET broadcast should be provided with an Inmarsat-C receiver or have another arrangement to monitor the broadcasts they originate to confirm that the messages are transmitted and received correctly (paragraph 1.2.1.4).

The authority responsible for setting up an MRCC should:

- *Contact the Chairman of the International SafetyNET Co-ordination Panel to ask him to prepare the certificates which will be issued so that the RCC can be considered as "information provider" and have access to the SafetyNET network for the purpose of search and rescue (4.2.1).*
- *Ask the local Inmarsat land-earth station operator in the country concerned about means of calling subscribers on the network (4.2.2)."*

3. The impact of the recognition of new satellite service providers to the MSI providers and the RCCs (the problem)

3.1 The interoperability definition used by the Correspondence Group is: "**ability to conduct ship-to-shore, ship-to-ship, and shore-to-ship communications without regard to differing satellite systems in use by the communicating stations."** This definition is broader than the problem under discussion, and it includes some factors for which the recognition of the Iridium does not pose any new or express problems. Ships, shipowners and companies would be able to use satellite communication irrespective of which company is providing services to whom.

3.2 Even considering the provided description, and the fact that the problem has been discussed as general interoperability, the real issues now becoming apparent are related to possible impacts on MSI providers and RCCs. For those actors, two different classes of impacts have been considered:

Financial impacts

3.3 MSI providers and RCC have two classes of costs they bear by themselves in order to support the global maritime community with reliable and timely safety information:

- The MSI providers pay for broadcasting MSI information. In SafetyNet, this information is sent to a contracted Land Earth Station, which performs the transmission. In addition, SafetyNet II provides a web interface to MSI providers to send their information directly to Inmarsat. In general, RCCs do not bear this cost since they usually broadcast only free of charge information.
- Both MSI providers and RCCs shall monitor their broadcasts. To do so, it is necessary to have a ship-earth-station terminal available, and to bear its associated costs.

3.4 These costs will increase linearly for each new satellite communication provider recognised in GMDSS; roughly doubling with the recognition of Iridium and tripling with the possible recognition of BeiDou in future, and so on and so forth.

Operational Impacts

3.5 Following the current regulations, MSI providers will have to install a ship-earth-station terminal for each new satellite service provider in order to monitor the broadcasts. Even now, with only one terminal, this monitoring is an intricate manual task, timing consuming, and error-prone.

3.6 Introduction of the new Iridium terminals will require MSI providers to train their staff accordingly and create new tasks for operators. It is also noted that RCCs and MSI providers operate critical services to the global maritime community, such as SAR or tsunami alarms, and their 24/7 staff is limited. For such activities, each new distraction will pose a risk, similarly as occur in ship's bridges. This impact cannot be disregarded or even measured as linearly increased. The time needed to monitor the broadcasting for the new satellite provider is currently allocated to other processes inside MSI providers and RCCs. Thus, this new task may affect their efficiency or require new staff.

Administrative impacts

3.7 This was not considered during the discussions; however, under the current regulatory framework, MSI providers and RCC will need to sign contracts with new providers or their representatives, usually on an annual basis. This task may not simple for some administrations, as involving bureaucratic processes.

4. Situation Summary

4.1 The current situation, considering the negative impacts to MSI providers and RCCs and the possible ways to mitigate them, as presented in the Modernization Plan of the GMDSS, are described in Table 1. The table also presents IMSO's views on possible impacts, implementation issues, and expected outcomes.

Table 1 - situation summary

Financial – broadcast cost	
Fact	• The costs of MSI shore-to-ship broadcasts fall on the MSI providers
Impact	• Costs will increase linearly
Suggestions	• Revision of Resolution A.707, to exempt shore-to-ship broadcasts of MSI from charges
Implementation issues	• Satellite communication providers may raise other charges to achieve economic equilibrium. • There are worries about overuse of MSI broadcast if it turns to be free of charge.
Expected outcome	• the negative financial impact is mitigated
Financial – monitoring	
Fact	• MSI providers and RCCs are required to monitor their broadcasts
Impact	• Costs will increase linearly; current regulation imposes monitoring through ship-earth-station, and new stations will be required for each new provider.

Suggestions	• Identify new ways to monitor MSI broadcasts over multiple GMDSS satellite service.
Implementation issues	• Until this moment, no consistent suggestion was presented. • There will be a paradigm rupture: the GMDSS was conceived in the 70's and 80's. The current monitoring approach does not take advantage of modern technologies.
Expected outcome	• No approach is defined.
Operational – EGC transmission	
Fact	• There exist two different arrangements in place: SafetyNet and SafetyNet II. The later allows MSI providers to send information directly to Inmarsat using a web-based interface. • Iridium will require some similar arrangement for receiving information.
Impact	• There will be the need to combine MSI from all sources and distribute the same to the various satellite service providers without duplication or omission. • Staff members will need training. • These new tasks will increase the workload of MSI providers and RCC. It may be the case that extra staff working 24/7 may be required.
Suggestions	• Establish common standards for messages. • Use standardised EGC adapted to a digital format. • Establish a Single Point of Distribution system, allowing MSI providers to send each message to a single point only for onward transmission. This system should replicate the messages to the correct destinations and forward their confirmation of receipt and broadcasting to MSI providers and RCC.
Implementation issues	• MSI providers, RCC and Satellite communication providers must comply with interface standards and communication protocol. • The single point of contact is 24/7 system. It requires contingency and recovery processes in place. • The maritime sector could benefit from the LRIT experience.
Expected outcome	• The workload of the MSI providers is not increased and a better, efficient and reliable solution is in use.
Operational – monitoring	
Fact	• MSI providers and RCCs are required to monitor their broadcasts using ship-earth-station terminals. This monitoring depends on human intervention. • The current recommended process requires the operator to manually check the reception of transmitted EGC message in the terminal and reset it after. This reset is to allow her/him to correctly ensure the subsequent reception; otherwise, the terminal will disregard the

	already received message. • This process is time-consuming and error-prone. It requires operators to be trained in each specific terminal operation. • The process was defined considering the technology used by Inmarsat. It ensures that the message was received by the satellite provider and transmitted, at least, to the region were the used ship-earth-station is located. Considering the broad regions covered by each Inmarsat satellite, this process was considered reliable until now. • There is no guaranty that the same process will suit Iridium or further satellite service providers. It is noted that Iridium's non-geostationary satellites individually cover smaller non-static regions compared to geostationary satellite constellations. On the other hand, they can provide coverage over the polar regions.
Impact	• The monitoring will consume more human resources of the MSI providers and RCCs which may affect their efficiency and introduce unforeseen operational risks. • It is likely that the current monitoring process will not be suitable for Iridium. A further consideration is needed. • It may be the case that new 24/7 staff would be required. For each position, four new employees are needed, on average.
Suggestions	• Identify new ways to monitor MSI broadcasts over multiple GMDSS satellite services.
Implementation issues	• No practical suggestion was presented until now. • There will be a paradigm rupture: the GMDSS was conceived in the 70's and 80's. The current monitoring approach does not take advantage of modern technologies and it is unlikely to suit the Iridium system.
Expected outcome	• No approach is defined.
Administrative – need of new contracts, agreements and arrangements	
Fact	• MSI providers and RCCs would be required to establish new contracts, agreements and arrangements to be able to communicate with new satellite service providers. • Depending on the internal arrangements of each entity, the contract establishment and management arrangements may vary, and may require public tenders and legal advice. • Usually, this activity requires time and periodical renew.
Impact	• Providers of MSI and SAR services will be required to bear this new burden.
Suggestions	• No consistent suggestion was presented until now.
Implementation issues	•
Expected outcome	• No approach is defined. • It is likely that the Single point of distribution should mitigate or eliminate this impact, if it is implemented.

5. Approaches towards solution

The current internal discussions considered three possible outcomes:

5.1 No changes in GMDSS regulation

- MSI providers and RCCs will bear the financial, operational and administrative burdens as consequence of Iridium's recognition, as well as for any new satellite service provider in the GMDSS;
- The EGC messages are not standardised at data (schema) level. This approach could lead to different standards for each provider;
- There will be an increase in the workload and operational risks to MSI providers and RCCs;
- Further applications from Satellite Communication Providers to be recognised in the GMDSS are likely to face opposition if such issues are not resolved; and
- Financial restrictions could lead some MSI providers or RCCs to opt for only broadcasting information through one satellite communication provider. Such fragmentation could prevent ships from receiving all MSI and SAR messages relevant to their area of operations or limiting ships sailing in certain waters to installing a ship-earth-station terminal specific to one particular service provider;

5.2 MSI information broadcasting is exempt of charge

- MSI providers and RCCs will have costs to monitor the broadcasting to the new system, and this impact is likely to be more relevant than the cost of transmission, considering the possible need of new staff;
- There will be an increase in workload and operational risks to MSI providers and RCCs; and
- The EGC messages are not standardised at data (schema) level. This approach could lead to different standards for each provider.

5.3 Single Point of Distribution

- This concept emerged from discussions related to the need for sending information to more than one service provider;
- Initially, single point of distribution was devised as a system able to receive messages (MSI or SAR message) from each provider. The messages would then be collated and distributed to all the satellite service providers;
- This solution encompasses the concept of a communication broker, able to receive information and redistribute it to all destinations; and
- The concept itself is not new to IMO since the LRIT IDE is a communication broker.

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ANNEX 2

Concept of Single Pont of Distribution System

1. Introduction

1.1 This document intends to provide a general idea of a possible implementation of the Single Pont of Distribution System (SPoD). The current level of detail allows readers to start technical discussions on the appropriate architecture, feasibility, associated costs, time-to-market and so on. This kind of prospective draft architecture is usual in the industry when discussing a pre-project.

1.2 The solution presents a new paradigm for monitoring. The service providers are responsible for confirming both the receipt and the broadcast of MSI and SAR messages, following the instructions they receive together with the message content. This information related to the monitoring will be transmitted by the service providers to the single point of distribution, which will provide this information to the MSI or SAR message originator. The MSI providers and RCCs interfaces present the sent messages and the follow-up information in a way that the operator could easily notice an anomaly.

1.3 The SPoD concept was based on the following considerations:

- It searched for a cost-effective solution, with more emphasis on reducing maintenance cost. This because it is generally assumed in the literature that 80% of the lifecycle cost is associated with this phase, that is, after the deployment in production. Moreover, the SPoD has no provision for being removed from service.
- The solution should be resilient, with redundant features and being able to recover from disasters.
- All features should benefit from industry standards and existing technologies. The architectural solution, in the same way, should follow architectural patterns and benefit from previous experiences. This is the most important decision in the inception since it reduces all risks related to the implementation and project execution, and these risks would have a significant impact if they occur.

2. The architecture

2.1 Figure 2 presents the overall vision of the system. This figure is not a technical diagram and is intended as a general overview. The architecture has four components and it is driven by the communication protocol.

The components

2.1.1 The On-site terminal

This comprise a rich client (local software), which is able to run in windows desktops with access to the Internet. This software is the same for all MSI providers and RCC and is developed and provided by the entity in charge of operating and managing the SPoD.

The On-site terminal offers protected access control for operators (e.g., by password), and a user-friendly interface to insert the EGC message and associated parameters, such as time of transmission and regions. These parameters are the ***envelope***, and the message text is the ***content***. All such information will be included in XML files and syntactically validated before transmission.

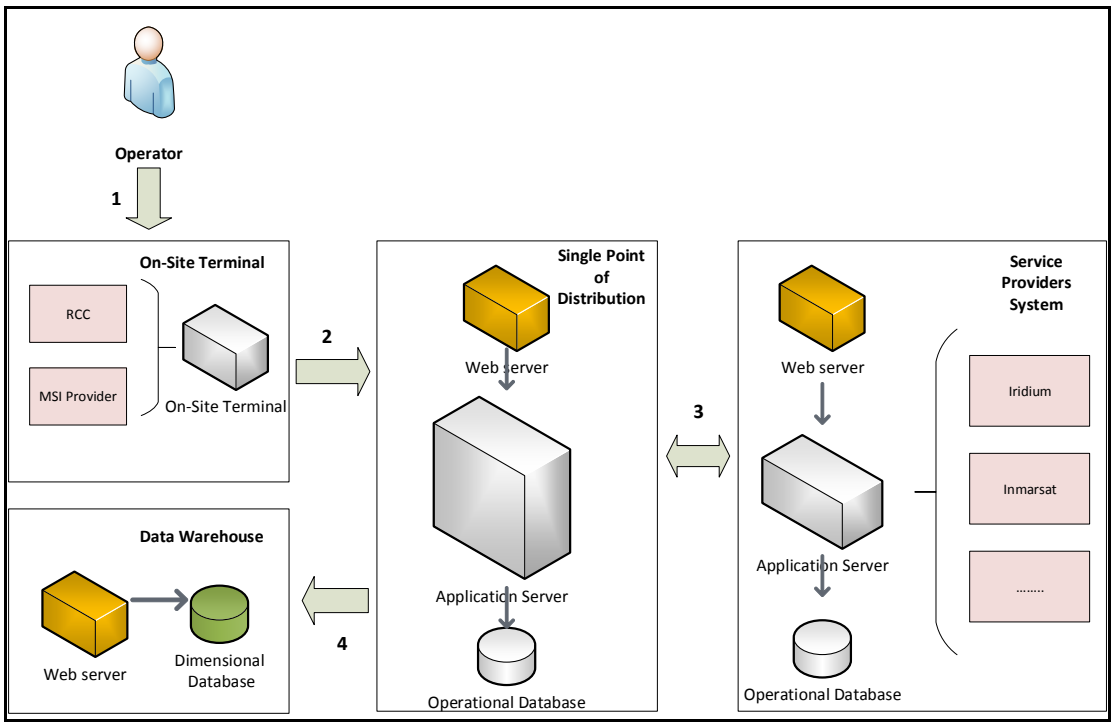

Figure 2- Architecture

All messages are saved in the local filesystem. The message is sent to the SPoD via web-services. Each message is uniquely identified in the system, and this is basic to the architectural solution.

The On-site terminal queries periodically the SPoD to verify incoming messages and fetch these. This solution is a composition of the ***query/respond*** and ***blackboard*** patterns – techniques used throughout the IT industry. This approach suits to terminals installed inside intranets and behind a firewall, usually using dynamic IP assignment.

For each sent EGC message, the terminal receives:

- A receipt from each service provider confirming the message was correctly processed and scheduled for transmission
- A receipt from each service provider for each successful broadcast, including the instant of transmission
- Any error messages

2.1.2. Single point of distribution

This system is the core of the architecture. It is a standard 3-tier layered architecture, with a user interface based in HTML (thin client), an application server responsible for processing and a local database system.

After receiving an EGC message from an on-site terminal the SPoD includes within the envelope the time of reception and generates the copies to the service providers. Some level of intelligence is required in order to forward messages only to the correct service provider, i.e., responsible for the destination area.

The envelope is increased with each new item of information; for example, the record of sending is also included. All messages persist in the operational database, and the system is a stateless system. This allows for recovery at any time based on the database information. All message handling is transactional. The pattern related to sending a message to the next stage with modifications is called "*pipe and filtering*".

For each ECG message from a MSI provider or RCC, the SPoD will set the origin as a future destination for any follow-up message that reference the original. Any receipt from service providers shall reference the original message.

After receiving a receipt from a service provider, the SPoD contact adds the needed information to the envelope and saves the message in the blackboard table. Periodically, the On-site terminal will enact a query about messages destined for them, and fetch these.

After each transaction, the message is stored indefinitely in the data warehouse.

2.1.3. Data warehouse

This system is an off-line relational database using dimensional modelling. No data is ever erased from this base, which will store all MSI and SAR messages (no edit or delete access for users). It is noted that no classified information flows as MSI or SAR, since this information is publicly broadcast.

The data warehouse is intended for public access and is responsible for transparency and allowing external control over the overall system performance. Moreover, this information will allow future statistical analysis. Nowadays there is no such information available to originators.

2.1.4. Service providers

Services providers should implement systems adhering to a recognized specification. The implementation described here is an example based on industry standards.

The same as for the SPoD, the service provider systems should be developed in a standard 3-tier layered architecture. All message handling is transactional, and all transactions are persisted in the operational database. This database is temporarily limited to 60 days. The system offers a web service for receiving incoming messages from the SPoD and, in the same way, the SPoD itself offers a web service to receive messages directly from the systems of the various service providers.

The interface between service providers and the single point of distribution does not need a blackboard since they send their messages as and when they are ready for transmission. They use a message handling system, and they need to implement preference queues to give preference to SAR traffic. Message queuing service libraries and framework provide this support for free.

2.2. The communication protocol

2.2.1 The architecture is said to be driven by the communication protocol because the message handling describes what occurs with the message along the communication pipeline, including actions triggered and modifications to the envelope (i.e filtering). This behaviour leads to classify this as a "pipe and filtering" architecture at a high level. The other used patterns lie below this abstraction layer and are related to implementation.

2.2.2 Each MSI or SAR message is uniquely identified by a message ID. This information, together with the originator, is the reference for all information flow and follow-up messages, such as receipts and broadcast notifications.

2.2.3 The communication protocol has check-points where information such as the current time is aggregated to the original message. These data are further used to verify global and individual components performance.

2.2.4 The Data Warehouse component is a public repository with all historical data, and all information flow is stored on it. This allows for both formal and informal external control, statistical analyses and transparency. The performance metrics should be further considered in system requirements or quality of service specification.

2.2.5 The communication protocol, in the context of the SPoD architecture, is a complete description of:

- Message syntax and semantics, both for envelop and content
- Message handling, including alternative flows

2.2.6 The message description is presented in a tabular way and contains all the message fields, the information contained in these fields, the format of data to be used and the identification of which component is responsible for writing the information. After being sent, only blank fields are filled for the next component; no content is edited or erased.

2.2.7 The communication protocol also includes the data format at lower level. This relates to XML schemas (XSD) with the data types.

2.2.8 The data interface between components is described as "services" and is an implementation of the Service Oriented Architecture (SOA). These services have a rigid interface to allow interoperability, and this interface is described as web services using the industry standard Simple Object Access Protocol (SOAP) [2]. The data description for the interface is provided using the Web Services Description Language (WSDL).

[2] https://www.w3.org/TR/soap/

2.2.9 The message handling describes the system process. A process presents the expected output for a given input, and this is the main description of requirements for internal message processing. Processes are also the core source of information for planning the component tests.

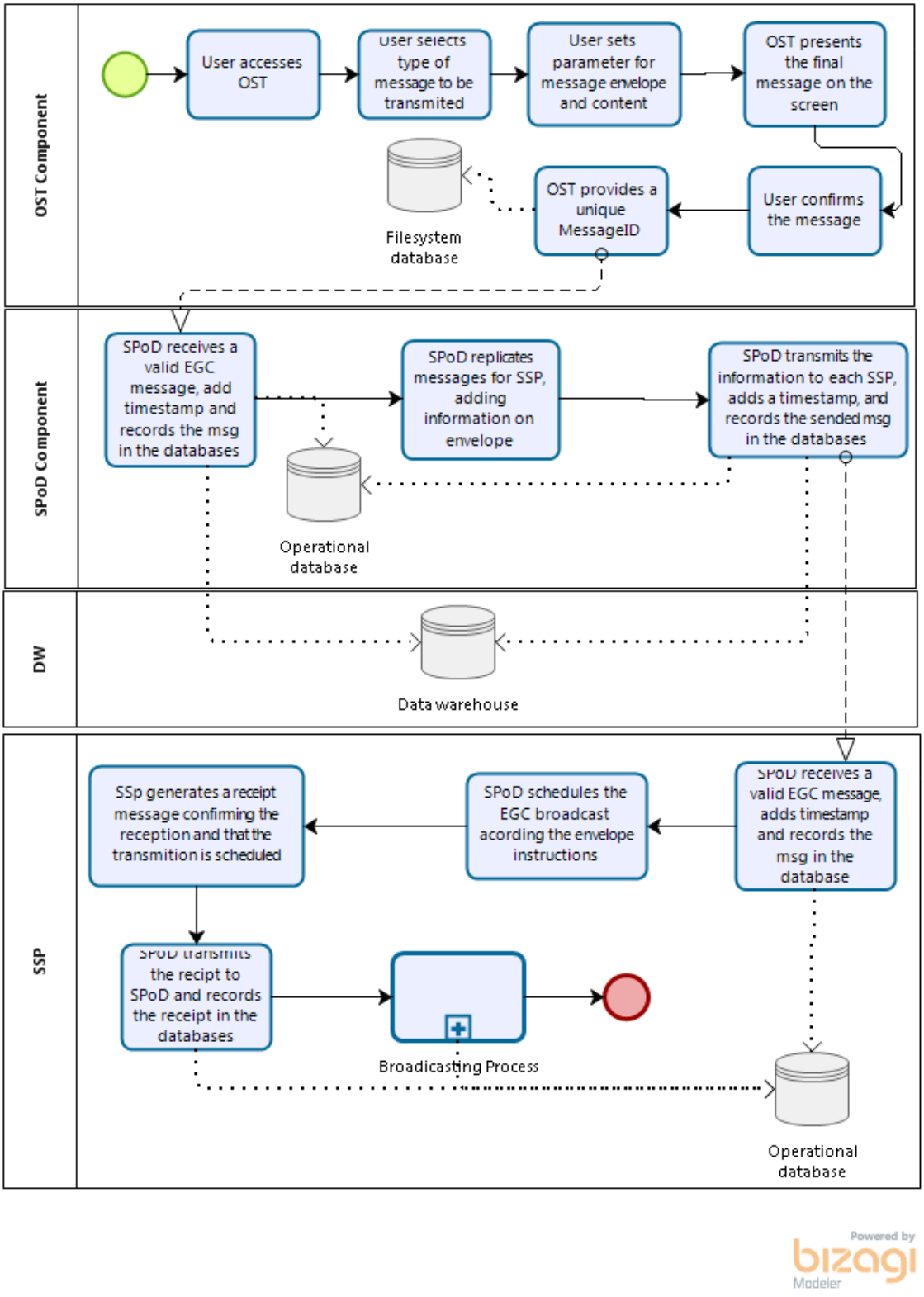

Figure 3 - Sending EGC message process

2.2.10 The message handling is described textually and sequentially, together with flow diagrams (ex. UML activity diagram or BPMN process diagram) to guide the reader. An example is provided in Figure 3, which presents the process of sending EGC messages.

3. Contingency levels

3.1 The proposed architecture is designed to provide failsafe procedures in two different levels:

- Level 1 – the MSI provider or RCC has no connection with the SPoD, because of failure in the terminal or lack of internet connection.
- Level 2 – the SPoD is out of service, or has lost its connection to the satellite service providers systems

3.2 There is no provision for contingency if a satellite service provider is out of service. In such an event, the SPoD system should continue operating as usual, but queuing all messages to be delivered to the said service provider when it returns to service.

3.3. Contingency Level 1

The on-site terminal informs the operator if it no longer has connection to the SPoD or if, for any reason, the terminal is unavailable, or the MSI provider or RCC has lost its connection to the internet (see Figure 4).

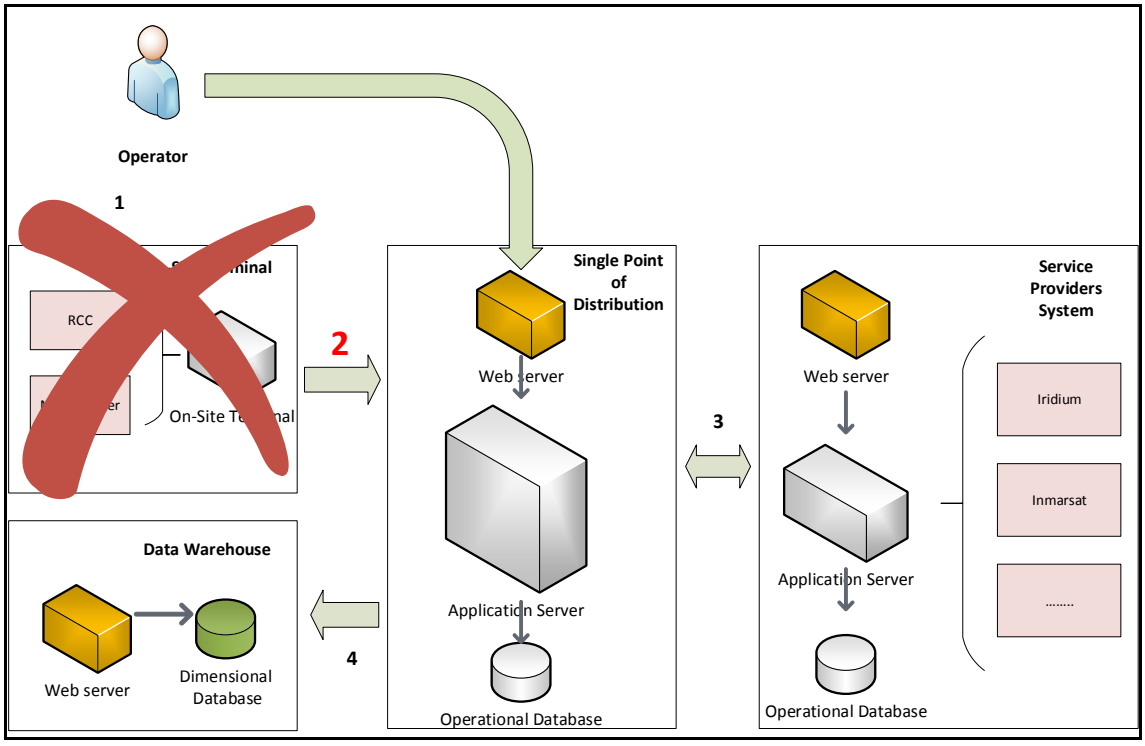

Figure 4- Contingency Level 1

For an operator duely registered and authorised to access the SPoD system directly through its website, the SPoD website will allow EGC messages to be created and sent. All traffic done through the web interface is replicated in the blackboard and remains available to be fetched by the failing MSI provider or RCC after recovering its normal operation.

Even if the MSI provider or RCC loses all data, it will be possible to recover the information from the Data Warehouse component.

3.4. Contingency Level 2

The on-site terminal informs the operator that it has no connection to the SPoD. The operator unsuccessfully tries to access the SPoD website (NB: some procedures to publish SPoD failure must be devised).

In the absence of SPoD availability, duly authorised operators may access the service providers' website (SPS). It will then be necessary to replicate the information manually in each provider system (see Figure 5). The SPS will store all traffic in a message queue ready to be delivered to the SPoD after recovery takes place.

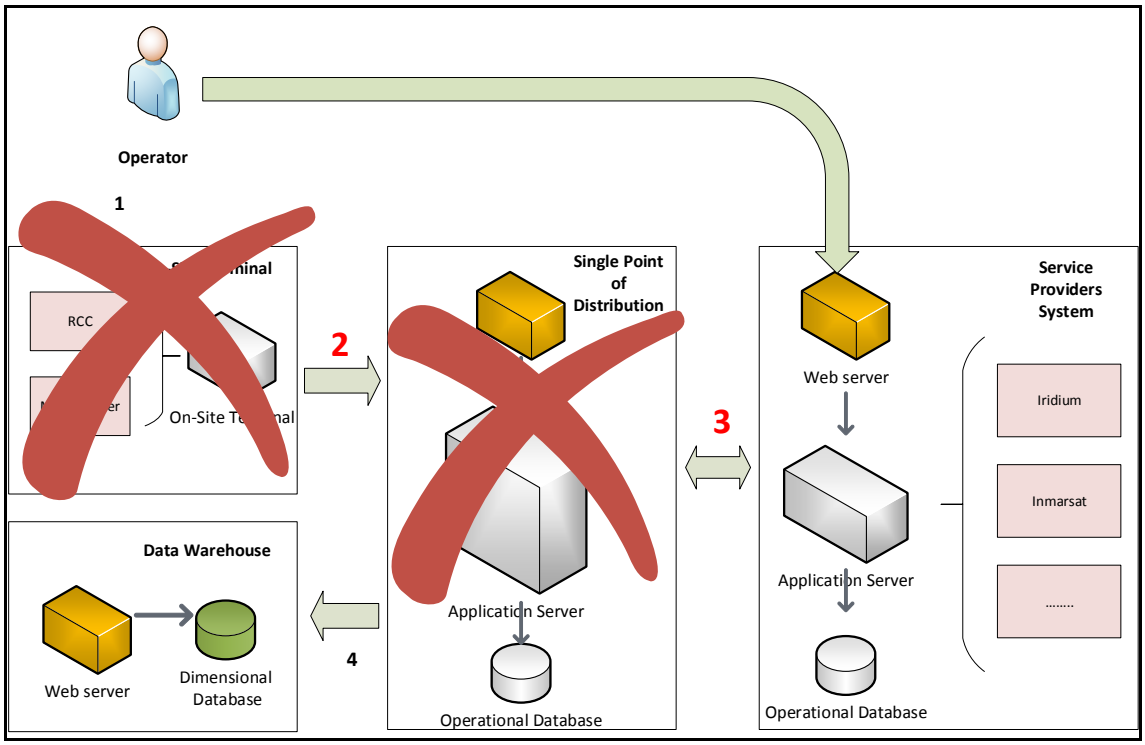

Figure 5- Contingency Level 2

3.5. Contingency levels notes

The contingency process does not require a 24/7 backup site, but an external data backup is needed.

To implement the proposed contingency approach, it is necessary to implement a user-management solution that propagates the user's credentials throughout all the components. Furthermore, as with any similar process, periodic exercises and drills will be needed to test the contingency arrangements. The manager of the SPoD is responsible for these activities.