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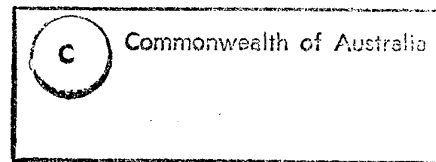
Vincent P. Scaffidi



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Vincent P. Scaffidi

**Communications Division
Electronics and Surveillance Research Laboratory**

DSTO-RR-0042

ABSTRACT

Military GSM (MGSM) is a term defined here to mean the redesigned and adapted use of civil Global System for Mobile communications (GSM) technology within military scenarios and isolated deployments. MGSM is a first step towards bringing the future benefits of personal mobile communications to the military user.

In this paper an overview is presented describing the concept of a MGSM architecture that is particularly suited to providing mobile wireless tactical telecommunications in the field. Subsequently, various possible Defence applications that exist for this concept and the set of issues to which they give rise are highlighted.

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EXECUTIVE SUMMARY

Personal communications is establishing itself as one of the fastest growing and most inherently significant high technology industries. The projected impact of personal communications is predicted by most analysts to parallel and even overshadow that of the personal computer revolution. Newer mobile communication technologies will begin to make a vast range of telephony and data communication services available to anyone, anywhere and at anytime. Eventually, the forging together of cellular, satellite and cordless based mobile communication technologies will enable the seamless integration of services within the one easy to carry (or wear !) multimode personal communications device.

Military GSM (MGSM) is a term defined here to mean the redesigned and adapted use of civil Global System for Mobile communications (GSM) technology within military scenarios and isolated deployments. In a global market with a growing diversity of technology options for the automatic delivery of mobile services via alternative means, it represents a critical first step towards Personal Military Communications (PMC).

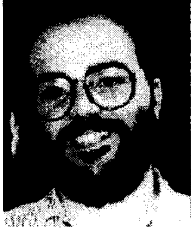
DSTO research on MGSM is focused on the following aspects :

- (a) Network mobility.
- (b) Single cell operation.
- (c) SECRET TACTICAL security.
- (d) An integrated MGSM architecture.
- (e) Military grade priority, pre-emption & multi-party conferencing etc.

The end goal of this research is to arrive at a cost-effective personal mobile wireless system of communications which will offer a wide range of benefits to the military user, particularly for tactical communications in the field. Benefits such as :

- (a) No wires.
- (b) User mobility.
- (c) Minimal setup time.
- (d) Minimal tear down time.
- (e) Minimal manpower requirements.
- (f) Anyone, anywhere, anytime personal communications within the coverage area.
- (g) Integrated telephony, switched and packet data, facsimile and messaging services.
- (h) A built-in growth path of future GSM services and applications.

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Vincent Scaffidi is the DSTO Task Manager for Project YUWA and is researching the military applications of digital mobile communications technologies.

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1. Introduction

Global System for Mobile communications (GSM) is an international civil standard for personal mobile communications. Its features include :

- (a) Personal mobility.
- (b) Wireless access.
- (c) State of the art digital technology.
- (d) Integrated telephony and data services.
- (e) A secure radio interface.
- (f) International roaming.
- (g) A cellular radio network architecture.
- (h) Centralised circuit switching.
- (i) A transferable Subscriber Identity Module (SIM).
- (j) Intelligent network functionality.

Military GSM (MGSM) is a term defined here to mean the redesigned and adapted use of civil GSM technology within military scenarios and isolated deployments.

DSTO research on MGSM is focused on the following aspects :

- (a) Network mobility.
- (b) Single cell operation.
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- (g) Integrated telephony, switched and packet data, facsimile and messaging services.
- (h) A built-in growth path of future GSM services and applications.

2. Aim

The aim of this paper is to describe the general concept and potential of MGSM in future military communications. Specifically, this paper :

- (a) Describes the concept of a MGSM architecture.
- (b) Identifies potential Defence applications for MGSM.
- (c) Identifies the issues in building MGSM upon civil based technology.

3. Scope

When considering the specific military context, the reader should remain aware of the distinct differences which exist between :

- (i) a large commercially operated GSM network designed to service the general public in sufficiently populated and commercially viable areas using a multi-cell interconnected and fixed infrastructure,

and
- (ii) a small Defence controlled and operated MGSM based network designed to service a limited set of Defence users located far away from both Defence and civil assets using a single cell, standalone and portable equipment configuration.

4. MGSM Architecture

4.1. Mobile Network

The basic building block underpinning the concept of a MGSM architecture is a small one cell, standalone and portable mobile wireless communications network designed to carry SECRET TACTICAL voice and data information within a concentrated deployed military unit like a Brigade Headquarters or a Brigade Maintenance Area as shown in Figure 1.

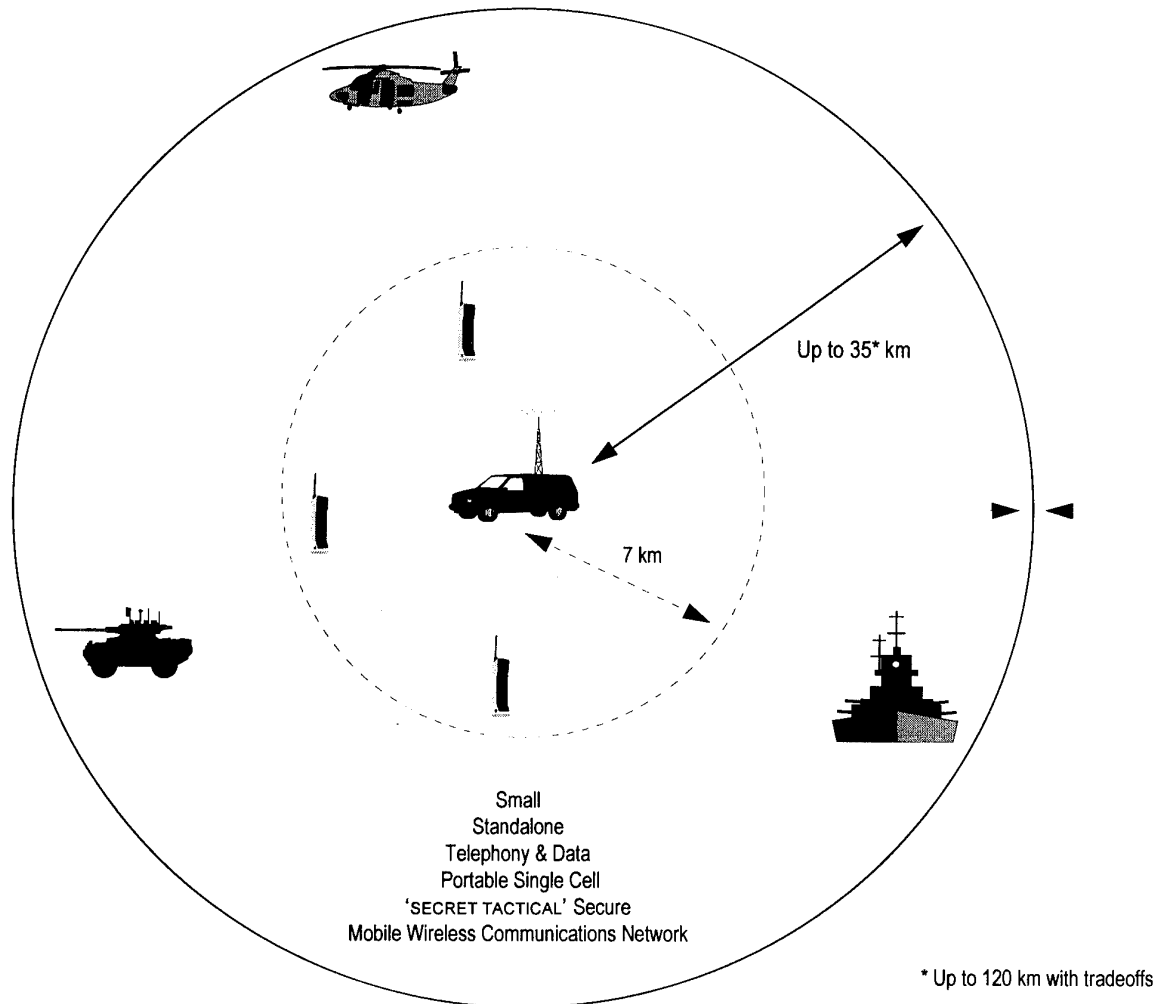


Figure 1 : MGSM Network

In describing this mobile MGSM network of Figure 1 :

- (a) Small ultimately implies being able to house the entire MGSM network in the back of a 4 wheel drive Land Rover. The physical security over network equipment provided by this arrangement means that the probability of interception in the otherwise vulnerable GSM wireline network is virtually zero.

- (b) Standalone implies that there is no dependency on any form of external infrastructure to enable local mobile wireless communications.
- (c) Telephony & Data implies that the mobile MGSM network will be able to accommodate data services using the same integrated architecture. Whereas the primary requirement or *killer application* for military users of MGSM is and may always remain anyone/anywhere/anytime personal telephony, data based services will undoubtedly be playing a bigger role in future tactical communications scenarios.
- (d) Portable implies that a deployed military unit can take the MGSM network with them anywhere they go¹. Once portability is achieved it is not beyond the realms of possibility for the MGSM network itself to become truly mobile. In this way personal mobile communications services could continue to be delivered to mobile military users at the same time as the vehicle carrying the network is being driven along.
- (e) Single cell implies that the radio network is no longer cellular per se, having no frequency re-use, no hand-off and no co-channel interference. More importantly, it means that there is no requirement to lay any sort of fixed wireline infrastructure in the field, making the network quickly deployable.
- (f) SECRET TACTICAL secure implies the ability of the system to handle perishable SECRET classified information for a minimum set period of time in given military tactical scenarios. To achieve this the GSM authentication and cipher key setting algorithms that reside in the SIM would be replaced by new military grade versions. Also, depending on a final decision based on various risk analysis criteria, the encryption algorithm in the GSM handset may also be replaced by a military version.²
- (g) 35 km refers to the configurable theoretical communications coverage radius under normal modes of operation.³ The actual coverage obtained in any given scenario will usually be terrain limited. Furthermore, low powered handheld phone coverage can be expected to be confined to within around 7 km of the central base station and network.

¹ Note, in Australia the coverage provided by civil GSM networks will probably never reach much beyond 5 % of the country's land area because it is unlikely that they would be commercially viable in areas of such low population density. Notwithstanding the use of satellite based communication systems, this in turn means that the only way of assuring true personal mobile communications services in the places of highest military interest (e.g. Northern Australia) is to bring along your own terrestrial network.

² Eventually, as the technology and international smart card standardisation allow, the encryption algorithm used in MGSM may be incorporated into the SIM.

³ Technically, it is possible to modify the operation of the network to allow coverage up to a radius of 120 km.

4.2. Integrated Mobile Networks

In the concept of a MGSM architecture each independent and distributed single cell MGSM network is interconnected and integrated into the larger area of military operations as required via a full or partially meshed series of wide area links running secured tactical trunking protocols (e.g. PARAKEET, secured N-ISDN or secured B-ISDN) over an appropriate combination of available transmission bearer systems (e.g. Satcom or Radio Relay) as shown in Figure 2. This concept of many independent single cell networks (one for each deployed military unit) interconnected together as required is in contrast to a typical GSM network architecture, which is made up of one fixed network of inter-dependent cells.

In this way the same rich set of secure personal mobile wireless telephony and data communication services could be delivered transparently across a whole range of strategic, operational and tactical scenarios.

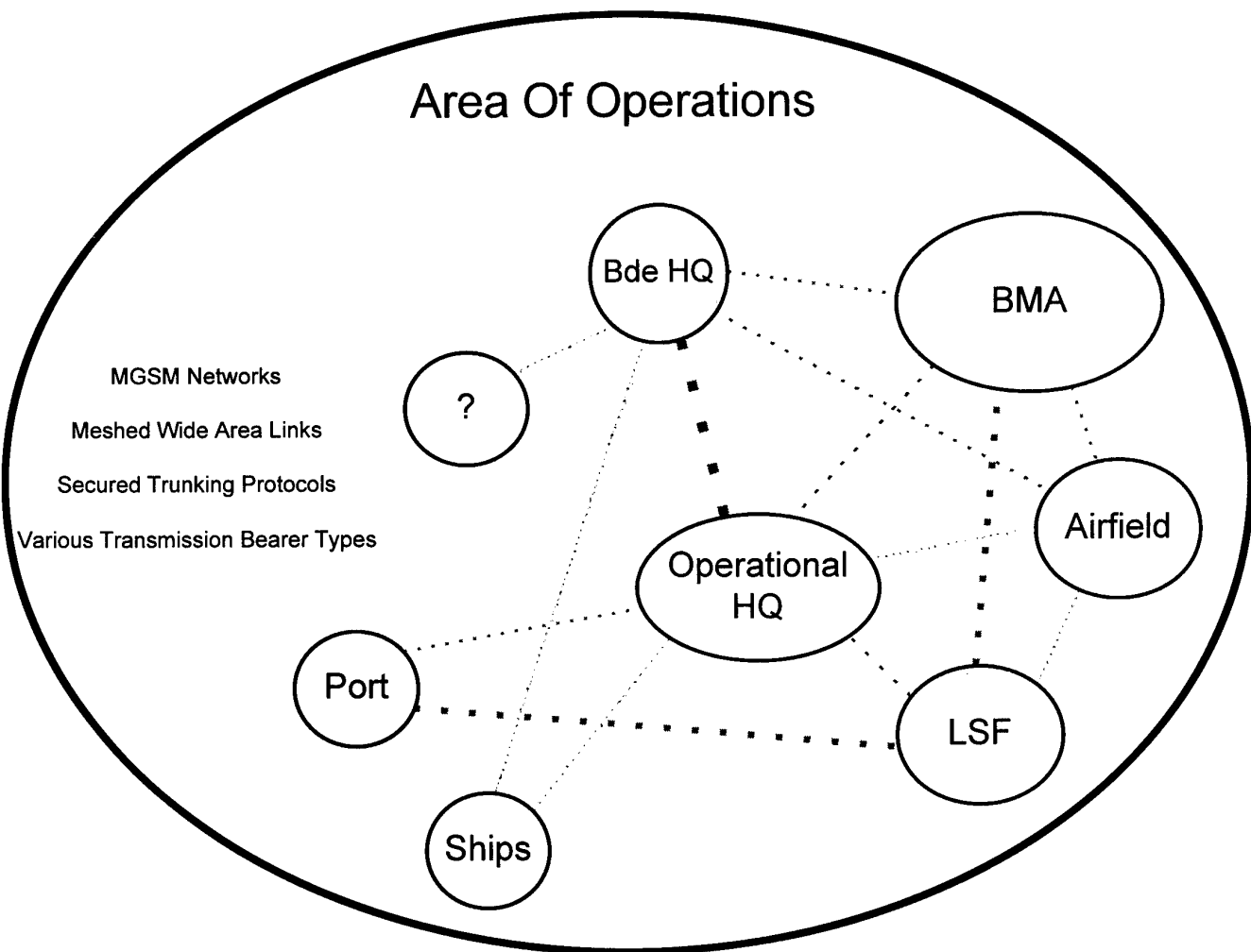


Figure 2 : Integrated MGSM Networks

5. Applications

The following is a list of potential application areas for the use of MGSM :

- (a) Tactical telephone communications.
- (b) Tactical wireless computer local area networking.
- (c) Mobile X.400 based military messaging.
- (d) Tactical (low speed) video conferencing.
- (e) PARAKEET Radio Access.
- (f) AUSTACCS Radio Access.
- (g) Overseas peace keeping missions.
- (h) Nation building missions.
- (i) Emergency disaster relief.
- (j) Patrol of RAAF airfields or secured areas.
- (k) RAN logistics installations.
- (l) Local ship to ship communications.⁴
- (m) Local ship to shore communications.⁵
- (n) Mobile End to end Secure Speech (MESS) across GSM and MGSM networks.

6. ISSUES

6.1. Deployment

Issues relating to the deployment of a mobile MGSM network include :

- (a) The time required to set up, tune and configure the network.
- (b) The time required to tear down and move the network.
- (c) The adaptability of the network to cope with any arbitrary topology.
- (d) The topology based concessions and/or limitations that arise.

⁴ The MGSM network would only need to reside on one ship. The other ships would only need mobile phones.

⁵ In one scenario here, a ship traveling within line of sight of the coastline and equipped with only a mobile phone could pick up and communicate through strategically deployed MGSM networks or, using MESS, through the civil GSM networks.

- (e) The smallest network configuration feasible.
- (f) The powering requirements for all of the equipment required.
- (g) The amount of ruggedisation required.

6.2. Interfacing

Issues concerning the interfacing of a mobile MGSM network to other assets include :

- (a) Providing appropriate access to nearby and remote civil communications.
- (b) Providing appropriate access to existing Defence communications assets.

6.3. Radio Aspects

Issues relating to the radio aspects of a mobile MGSM network include:

- (a) Any interference problems with Defence equipment or personnel.
- (b) Any interference problems with other radio networks.
- (c) The radio emanations and signatures present.
- (d) The vulnerability of the system to jamming.
- (e) Any radio propagation problems.

6.4. Cell Configuration

Technical issues in the configuration and tuning of a MGSM network include :

- (a) The most appropriate means of cell excitation.
- (b) The range of transmit power levels used.
- (c) Determination of the cell size.
- (d) The number of radio frequency carriers used per cell.
- (e) The type of antennas used.
- (f) The location of antennas and the setting of their heights.
- (g) Optimisation of all of the GSM base station software parameters.⁶

⁶ There are well over one hundred of these parameters.

6.5. Security

Issues relating to the security of a MGSM network include :

- (a) Replacing the GSM cryptographic functions with military grade equivalents.
- (b) The security of the military authentication and cipher key setting algorithms used.
- (c) The security of the military encryption algorithm used.
- (d) The probability of interception on the radio interface.
- (e) The probability of spoofing on the radio interface.

6.6. Phones

Issues relating to the use of MGSM mobile phones include :

- (a) The allocation of mobile phones.
- (b) The allocation of phone numbers.
- (c) The configuration of Subscriber Identity Modules (SIMs).
- (d) The recharging of mobile phones in the field.

6.7. Other

Other issues include :

- (a) The eventual size and cost of providing a mobile MGSM network.
- (b) The survivability of a mobile MGSM network.
- (c) RF radiation hazards associated with the use of any MGSM equipment.
- (d) Roaming between MGSM networks.
- (e) Provision of GSM spectrum or allocation of MGSM spectrum.
- (f) Legal aspects of licensing and operating GSM based technology.

7. Conclusions

In accordance with the Defence Communications Corporate Plan (DCCP), the Defence Department is looking to exploit state of the art commercially available civil communication technologies and their associated advantages (e.g. cost, functionality, integration, shorter procurement cycles, etc.). GSM is an international standard for personal mobile communications which falls under this umbrella.

MGSM will provide all of the mobile wireless telephony and data capabilities that GSM has to offer in military specific settings. MGSM does this while at the same time alleviating the various inadequacies of using GSM in remote isolated military deployments (e.g. remote central switching dependency and local speech delay) and improving on some of the key military communication attributes required (e.g. security).

Note, it may not prove to be feasible or cost effective to design out certain GSM military vulnerabilities in MGSM. As such, it will become a matter of acknowledging the strengths and the weaknesses in what will emerge as the final look MGSM and dealing with them accordingly.

Overall, however, it is considered that MGSM has the potential to greatly improve the capability of current and future Defence communications, particularly in tactical settings. This potential is being addressed as part of the Defence Project YUWA, which is a HQADF sponsored DSTO research task investigating the broader military applications of digital mobile communications technologies.

8. Further Information

Related information may be obtained on a restricted basis from the following sources :

- | | |
|---|--------------------|
| "Project YUWA - Defence Project" | - LTCOL M. Callen. |
| "Project YUWA - DSTO R&D Task" | - V. Scaffidi. |
| "Project YUWA - Mobile Wireless Tactical Telecommunications
Concept Demonstrator Trial Report" | - V. Scaffidi. |
| "Project YUWA - Military GSM Call Security" | - V. Scaffidi. |
| "Project YUWA - Choice Of GSM" | - V. Scaffidi. |
| "Military GSM - A Step Towards Personal Military Communications" | - V. Scaffidi. |

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9. Abbreviations

B-ISDN	Broadband Integrated Services Digital Network.
DCCP	Defence Communications Corporate Plan.
DSTO	Defence Science & Technology Organisation.
GSM	Global System for Mobile communications.
HQADF	Headquarters Australian Defence Force.
MESS	Mobile End to end Secure Speech - an offshoot project to provide military secure end to end speech between GSM global commercial network users and/or MGSM military users.
MGSM	Military GSM.
N-ISDN	Narrowband Integrated Services Digital Network.
PMC	Personal Military Communications. The (near) global wireless access by military users from a single multi-mode phone to secure and individually customisable mobile communications services (e.g. telephony, facsimile, switched data, packet data and messaging) through diverse, complementary and integrated terrestrial and satellite based networks.
SIM	Subscriber Identity Module - the GSM smart card containing subscriber and security related information and functions.
YUWA	A HQADF sponsored DSTO research task investigating the military applications of digital mobile communications technologies.

Military GSM

Vincent P. Scaffidi

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