Program at a glance

	Wednesday 25th	Thursday 26th	Friday 27th
09:30 - 10:00	Registration	Keynote Talk Armann Ingolfsson	Registration
10:00 - 10:30	Opening		Keynote Talk Shane Henderson
10:30 - 11:00	Keynote Talk Armann Ingolfsson	Coffee Break	
11:00 - 11:30		DAM & Dispatching	Coffee Break & Posters
11:30 - 12:00	Coffee Break		Practitioners Talks
12:00 - 12:30	Forecasting	Lunch	
12:30 - 13:00			Group photo / Lunch
13:00 - 13:30	Lunch	Keynote Talk Shane Henderson	
13:30 - 14:00			
14:00 - 14:30	Locations	Invited Talk Henk Post	Practitioners Talks
14:30 - 15:00		Coffee Break	
15:00 - 15:30	Coffee Break	EMS in Boarder Regions	Coffee Break
15:30 - 16:00	Patient Transportations	Invited Talk Verena Schmid	Practitioners Talk
16:00 - 16:30	Master Presentations	Scientific Wrap-up	Practical Wrap-up
16:30 - 17:00			Drinks
17:00 - 17:30	Drinks & Posters		
17:30 - 18:00			
18:00 - 18:30			
18:30 - 19:00			
19:00 - end		Conference Dinner	

Program

Wednesday June 25th

Keynote Talk	**10:30 – 11:30**

Forecasting EMS demand, response times, and workload
Armann Ingolfsson

I discuss the use of the call-by-call data that modern EMS systems collect, together with road network information, to investigate the following three components that are required as input information for mathematical models of EMS systems: (1) demand—how call volumes vary over time and space; (2) response times—how the response time to a call varies with the distance that the ambulance must travel, and perhaps other factors; and (3) workload—how long an ambulance and its crew will be occupied with a call.

Forecasting	**12:00 – 13:00**

CAS: Crime Anticipation System
Dick Willems

Steven Spielberg's movie "Minority Report" has established an image for the public of how police forces can predict crime. Right before the enraged husband uses a pair of scissors to kill his cheating wife, a SWAT-team rushes in and arrests the would-be murderer. The crime is prevented and the near-perpetrator is being locked behind bars. Of course this is fiction, but it is certainly possible to use mathematical techniques to predict crime and, using targeted patrolling, to prevent it. The Amsterdam Police has developed such a predictive system and designed a work process to make the city safer.

Demand forecasting of Asian and European EMS with spatial analysis

Thomas Krafft

Not received.

A simulation model for predicting the emergency service system state in near future

Hien Nguyen

A discrete event simulation model is constructed to predict the system state for an emergency medical services (EMS) system in the near future. It takes a snapshot of the current EMS state as the initial condition, simulates the EMS operations, and provides a possible future system state as a result. In order to capture various aspects of the future state, multiple replications have to be run from the same snapshot, resulting in a large number of simulated results. For the results to be useful, they are then analyzed, e.g. regarding the expected coverage. The analysis can be used to support operational decisions i.e. dispatch and relocation decisions.

Time-dependent ambulance allocation considering data-driven empirically required coverage

Dirk Degel

Empirical studies considering the (re)location of ambulances provide important insight into dynamic changes. Within a 24-h day, demand, travel time/speed and areas of coverage change. Most approaches require a (temporally and spatially) fixed (double) coverage. Neglecting these variations leads to an inaccurate estimation of demand. Through extensive data collection the required coverage of demand areas is determined. Our integer linear programming model (re)locates ambulances by optimizing the flexible, empirically determined required coverage, adjusted for variations due to day-time and site. A comprehensive case study shows that these objectives are achieved and lead to cost-effectiveness and quality improvement.

Robustness of the Maximal Covering Location Problem

Rutger Kerkkamp

The Maximal Covering Location Problem (MCLP) is one of the first facility location models used in emergency medical service. The MCLP determines the ambulance base locations such that a maximum number of demand points can be reached in time by ambulances.

We analyse the robustness of the MCLP with respect to changes in demand. The case study is based on The Netherlands. We derive the Robust Counterpart MCLP, which is robust to perturbations in demand. Using the Robust Counterpart MCLP we show that the MCLP is robust for certain perturbations in demand.

Patient Transportations 15:30 – 16:15

Planning EMS patient transports

Melanie Reuter

EMS systems in Germany are responsible for emergency services and transports of patients with the attendance of emergency medical assistants. Even if many of the transportation tasks are known in advance, trips are usually not planned, especially not automatically.
One of the main problems are waiting times for the patients when ambulances arrive too late, but also waiting times for the staff, if patients are not ready to be picked up.
We present a mathematical formulation for the transportation problem and solve it with (online) heuristics to include short-term demands.
We use data from a German rescue coordination center.

Incorporating coverage for emergency calls in scheduling patient transportations

Pieter van den Berg

Many ambulance providers operate both advanced life support (ALS) and basic life support (BLS) ambulances. Typically, emergency calls can only be executed by ALS vehicles, whereas patient transportations can either be served by an ALS or a BLS ambulance. BLS vehicle capacity does normally not suffice for all transportation requests. The remaining transportations are performed by ALS ambulances, which reduces coverage for emergency calls. We present a model to determine routes for BLS vehicles, so as to maximize the remaining coverage by ALS ambulances. Eventually, this should result in an online optimization model that dynamically schedules BLS vehicles.

Extending Emergency Medical Services for out-of-hospital cardiac arrest patients

Tef Jansma

Effective treatment of Out-Of-Hospital Cardiac Arrest Patients sets high demands on responsiveness of Emergency Medical Services. Ideally, life-saving treatment should start within 4 minutes after its occurrence. Unfortunately, current set-up of the Dutch Emergency Medical Services does not allow for such responsiveness, as it has been tailored towards a blue lights response of at most 15 minutes. In this project we explore cost-effective opportunities for extending the Emergency Medical Services of the Dutch province of Drenthe by employing volunteers, firefighters and police, thereby seeking to exploit their close proximity to the patients. Simulation results indicate a potential increase of patient survival rates from about 11% to 25%.

The offload zone as a solution to the offload delay of the emergency medical services

Corine Laan

In Canada, overcrowding of the emergency department is a widespread problem and one of the consequences of this overcrowding is offload delay. The Halifax Infirmary implemented an offload zone as a solution to the offload delay problem. Essentially, the offload zone serves as a buffer between the ambulance and the emergency department. This research investigates the impact of the offload zone. We propose a continuous time Markov chain to compare the performance of the emergency department with and without an offload zone. This model is compared with a discrete event simulation which allows additional metrics to be evaluated.

Forecasting call volumes for ambulance services

Maria Mahfoud

In planning the deployment of ambulances, forecasting the amount of emergency calls is an essential element. The goal of this research was to develop new methods for forecasting the emergency call volume.

The preliminary data-analysis revealed different seasonalities, therefore a multiplicative model was developed and improved. The forecasts of this adjusted model were compared with more sophisticated time series models, revealing that the adjusted multiplicative model produces superior mid-term and longer-term forecasts, which are the most important for the ambulance planning, however it was found that the model preforms poorly on the short-term forecasts.

Thursday June 26th

Keynote Talk	09:30 – 10:30

EMS performance evaluation with analytical stochastic models
Armann Ingolfsson

I discuss the use of stochastic models to predict how EMS system performance changes as the deployment of ambulances changes. EMS performance evaluation models have evolved to incorporate vehicle unavailability, random inter-arrival and service times, distinguishable servers, and vehicle repositioning. I illustrate the characteristics of and relationships between different model types.

DAM & Dispatching	11:00 – 12:00

Dynamic Ambulance Management: from theory to case studies
Sandjai Bhulai

The challenges of contemporary Dynamic Ambulance Management (DAM) are moving beyond cost efficiency towards superior customer service. Classical methods have addressed extensively the issue of cost efficiency by developing a priori redeployment plans in a wide spectrum of practical problems. However, although necessary, this is by no means sufficient to address events that are likely to occur during plan execution and significantly affect system performance. The ability to deal with such cases in satisfactory manner is increasingly important to the competitiveness of ambulance logistics. In this talk we aim to highlight important advances in the field of DAM. The fundamental problem of real time ambulance redeployment is defined and solution methods are presented and classified.

Minimizing average response times in a Dynamic Ambulance Management model
Thije van Barneveld

In Dynamic Ambulance Management, the most common performance measure used in practice is the number of patients for which a certain maximum allowed response time is exceeded. However, this creates bad incentives: a patient that is waiting longer than the maximum allowed response time does not count in the service level. Hence, there is no incentive to serve that patient. This is not the paragon of patient-oriented care, since every minute of delay can make a huge impact on the probability of survival. In this talk, we propose a model in which the average response time is minimized and we present a heuristic for making proactive redeployment actions.

A polynomial time method for real-time ambulance redeployment
Caroline Jagtenberg

We address the problem of ambulance repositioning in real time. The goal is to minimize the fraction of response times longer than a certain threshold. Dynamic ambulance management is generally considered a difficult problem, and exact solution methods quickly become intractable. Therefore, we propose a heuristic that is intuitive and scalable. We evaluate the performance through a simulation model of EMS operations. For a tractable problem instance, we show that the heuristic performs better than the optimal static solution. For a realistic case study, we show that the performance is a 16.8% relative improvement on a benchmark static solution.

Keynote Talk **13:00 – 14:00**

Vehicle mix in EMS systems
Shane Henderson

Some cities operate a mix of advanced life support (ALS) and basic life support (BLS) ambulances, while others operate an all-ALS fleet. Which is better? To explore one aspect of this question we construct two models - one a Markov decision process, the other an integer program - to examine dispatching and deployment decisions. In each case, the objective function value attained by an optimal decision serves as a performance measure by which vehicle mixes can be evaluated. Numerical experiments performed on a large-scale EMS system with these models suggest that a wide range of tiered systems can perform comparably to all-ALS fleets, provided that the fleet includes a sufficient number of ALS vehicles.

The Markov decision process and the integer program both represent different modeling compromises for mathematical tractability, and each can be viewed as an approximation of a stochastic simulation model of ambulance operations. Bounds on potential performance for the simulation model can be used in many ways in ambulance modeling. A bound on potential performance for an all-ALS fleet can be computed, but no extension to tiered systems is known. If time allows then I will review this bound and the complexities associated with trying to extend the bound to tiered systems.

Invited Talk **14:00 – 14:30**

The Shortest Path Problem in Emergency Vehicle Routing
Henk Post

Mathematical models of optimization problems related to Emergency Vehicle Routing (EMR) commonly assume that there is a timetable available. This should provide an accurate travel duration forecast between each pair of locations in the model. However, there are situations in which the travel time has to be calculated instantly. In that case, a sufficiently quick algorithm should be used for the Shortest Path Problem. In this presentation, we focus on the following subjects:

- (Pre)computing Shortest Paths;
- Visualizing the area within immediate reach of an Emergency Vehicle (within a certain time).

EMS in Boarder Regions **15:00 – 15:45**

Cross-border emergency care
Manon Bruens, Alexandra Ziemann

Cross-border emergency care in the EUREGIO border region between the Netherlands and Germany can often only reach legal travel-time targets if services from the neighboring country are helping out. Decision makers have agreed on a strategic plan to reach a borderless emergency care by 2022. We have inventoried the services and capacities on each side of the border and have identified practical, legal and financial obstacles and potential solutions to establish cross-border emergency care. Future challenges include cross-border ambulance steering, GPS-based fleet mapping, and exchange of real-time information on vehicles between German and Dutch dispatch centers.

Ambulance planning with and without region borders
Theresia van Essen

Border regions are a major challenge in ambulance planning. The border regions obviously occur between countries, but often also within a country. These borders within a country lead to an inefficient use of ambulances as it often happens that there are ambulance bases on both sides of the border even though one ambulance base could serve both sides simultaneously. In this talk, we first introduce solution approaches for efficiently locating ambulance bases and ambulances. Second, we show the improvement in terms of coverage and efficiency when borders between regions in a country are ignored.

Invited Talk	**15:45 – 16:15**

Solving the dynamic ambulance relocation and dispatching problem using approximate dynamic programming
Verena Schmidt

Emergency service providers need to locate ambulances such that in an emergency patients can be reached in a time-efficient manner. Once a request emerges a vehicle needs to be dispatched and send to the requests' site. After having served a request the vehicle shall be relocated to its next waiting location.
We are going to propose a model and solve the underlying optimization problem using approximate dynamic programming.
Empirical tests based on real data from the city of Vienna indicate that by deviating from the classical dispatching rules, the average response time can be decreased. Furthermore we show that it is essential to consider time-dependent information such as travel times and the request volume.

Friday June 27th

Keynote Talk	**10:00 – 11:00**

Operations Research in EMS in the past, present and future
Shane Henderson

Operations research techniques employ a combination of mathematics, statistics and computation to help in planning for complex systems. I will discuss these tools and their application in EMS systems, with an emphasis on how they have proven useful in EMS applications to date. I will then try to engender a discussion about what academia might most usefully explore in EMS applications in the near future by proposing several potential avenues for future applied research.

Practitioners Talks	**11:30 – 12:30**

The Optima Corporation – delivering commercially proven simulation based planning and deployment solutions for global Emergency Services
Tim Lynskey, Geoff Goodhew

The Optima Corporation of New Zealand provides commercially proven simulation based planning and deployment software designed specifically for Emergency Services. In this presentation we will discuss real world examples from our global customer base that illustrate how our simulation model is being used for emergency planning. We will also discuss the key features of Optima Live and show how our customers use dynamic deployment to optimise their geographic coverage to improve response times and patient outcomes.

Edge of tomorrow
Jaap Hatenboer

Time travel movies are big in the motion picture world. The most recent is "Edge of tomorrow". Our hero is Major Bill Cage who had never been in combat. The enemy is alien and extremely good. Cage is killed on the battle field within minutes, but he awakens back at the beginning of the same day, and is forced to fight and die again and again. With each pass, Cage becomes tougher and smarter.

Each repeated battle becomes an opportunity to find the key to annihilating the alien invaders and save Earth.

So why is this relevant for a Dutch ambulance service? Recently we got our own “time machine” in the physical form of a standalone computer with a simulation package.

Practitioners Talks 14:00 – 15:00

Performance evaluation and optimisation through the TIFAR-framework.

Martin van Buuren

In times of budget cuts and increasing demand on EMS, it is of importance that all available resources are used as efficient as possible. The TIFAR-framework is an extensive C++-based simulation and optimisation framework that can be used to evaluate dispatch and relocation strategies, optimise staffing and even includes call center staffing. The outcomes of these TIFAR-tools can be used on a strategic level of EMS providers. In this presentation we will discuss the inner workings of the tool, and give demonstrations of various parts.

Strategic capacity modelling and dynamic ambulance management

Geert Jan Kommer

Capacity modeling is concerned with determining the number of ambulances needed to meet the demand for ambulance care. These models are defined at some geographical level and are based on a number of constraints and assumptions regarding the expected performance of ambulance care and the system the services have to operate in. Models for dynamic ambulance management on often use capacity as in input and optimize the performance of ambulance services by means of clever dispatch and relocation rules. Strategic capacity models have to deal with the trade-off between increasing the number of ambulances to achieve better performance and limited budget constraints.

RBS Care: The intelligence system for the dispatch centre

Michiel Bijleveld

As from 2014 several dispatch centres will be merged into ten central dispatch centres within The Netherlands. Consequently, the medical dispatchers will have to operate in a larger region; on itself already a challenging task. Meanwhile there is a need to improve the performances in the ambulance care sector while using the same funding. Within the scope of these circumstances the question then arises: How do we make it possible to control a larger region, process more emergency calls and still improve the quality of care?
Knowledge and experience of medical dispatchers will become more critical. However, these human skills have to be supported by an accurate and reliable system. RBS Care can provide the means to accomplish this goal. The RBS Care system is specifically developed for the ambulance care sector and supports the expertise of a medical dispatcher. RBS Care uses a systematical approach to differentiate various types of ambulance care and - by using its own planning system – it optimizes the distribution and availability of resources. By using RBS Care the ambulance capacity will be utilized to a maximum while at the same time diminishing the pressure put on the dispatch centre.