Teaching Case

The Rescue911 Emergency Response Information System (ERIS): A Systems Development Project Case

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ABSTRACT

This teaching case presents a systems development project useful for courses in object-oriented analysis and design. The case has a strong focus on the business, methodology, modeling and implementation aspects of systems development. The case is centered on a fictitious ambulance and emergency services company (Rescue911). The case describes that the company's current systems no longer meet their business requirements and outlines the need for a new systems solution. The new situation is presented in form of business requirements, a conceptual system breakdown and interviews with the stakeholders. The teaching notes present business process and object-oriented analysis diagrams to complement the case. Students are confronted with realistic and different categories of business artifacts as input for their systems development project. Suggested project deliverables are outlined.

Keywords: Systems Development, Teaching Case, Business Process, User Requirements, Methodology, Modeling, UML

1. BACKGROUND

1.1 Introduction

The Rescue911 systems development project case was written for use in a higher level undergraduate systems development project course. The case write-up is based on the guidelines presented by Cappel and Schwager (2002). Firstly, the case is classified as a fictional project-based case, which, according to Cappel and Schwager (2002), requires realism but does not intend to depict an actual organization.

As a project-based or "systems solution" case, it is specifically suited for one or more courses in systems analysis, design and programming. It is particularly useful for team-based projects of between 3 and 4 students. It was designed to allow students the opportunity to apply their knowledge of object-oriented systems analysis and design. In particular, the case provides students an opportunity to produce package diagrams, activity diagrams, use case diagrams, use case descriptions, class diagrams, sequence diagrams, state-machine diagrams, database schema and eventually implementation of the system through code. The case is also helpful in teaching students front-end user interface design skills. In more technical classes, the case provides an opportunity for students to discuss options for systems architecture.

The case context reinforces the timeless issue of service delivery in emergency healthcare and depicts the emergency response dispatch process as an essential component of local emergency medical services (EMS). The authors examined packaged software applications, textbooks with similar case scenarios (Brady and Monk, 2007), websites of emergency services companies and national academies of emergency dispatch, and blended with personal experience to ensure necessary realism and detail (Cappel and Schwager, 2002). The following sections present the learning objectives for the project and an overview of the fictitious Rescue911 business. Then, in the form of a problem statement, the paper presents "the hook" (Cappel and Schwager, 2002). This is intended to grab students' interest by outlining the problems that occur when an organization outgrows its existing information systems. The system requirements and detailed case content are then presented in the format of transcribed interviews with key stakeholders. This format is intended to help students visualize the organization and its operations.

1.2 Learning Objectives

The main objective of the case is to teach the concepts of object-oriented systems analysis and design in a semi-realistic setting. The case provides an opportunity to teach various business, methodological, systems modeling and implementation issues in systems development.

1. Business aspect
    a. The case describes a realistic setting with a fictitious emergency response company.

   b. The case for action is an increase in business activities resulting in an information technology environment no longer meeting business requirements.
   c. The case shows a business centric approach to systems development by focusing on embedding new systems into the company's value chain, business processes and organization structure.
   d. The case supports the idea of digitized and integrated business processes.
2. Methodology aspect
   a. The case is presenting the situation after some efforts have been spent in a systems investigation phase.
   b. The case uses different artifacts which are typical input documents for a systems analysis and design effort (e.g. requirements list and minutes of interviews with the system stakeholders).
3. Modeling aspect
   a. The case presents students an opportunity to produce systems analysis and design artifacts using current notations (e.g. BPMN, UML).
   b. The project requires students to understand models reflecting different levels of abstraction and to appreciate the value and scope of modeling in a systems development project.
4. Implementation aspect
   a. The project provides an opportunity for students to implement a running software system based on state-of-the-art application architecture (e.g. web-based clients, application and database server including relational database management system software).
   b. The project requires students to apply and reflect on basic project management techniques throughout the assignment.
   c. The project provides an opportunity to expose students to group dynamics and behavior in a team and role based systems development effort.

2. THE CASE

The following sections provide an overview of Rescue911, providing background to the business, problems experienced, and requirements for the new system. Additional detailed information is presented in the form of data gathered from interviews with key stakeholders.

2.1 Overview

Rescue911 is an ambulance and emergency services company. The company operates a single 24-hour emergency operations call center in which all calls to Rescue911 are received and processed. Response teams are dispatched by call center operators. They are all trained emergency medical dispatchers. Rescue911 has approximately 2000 EMTs (emergency medical technicians) working in these response teams. Response teams are located at 25 base stations that are distributed across the geographic region serviced by Rescue911.

As a private ambulance and emergency services company, the assignment of response priorities and the coordination of the dispatch process are core to Rescue911's value offering. The dispatcher plays a key role in matching Rescue911's response capability to emergency situations. Rescue911 knows that the overall effectiveness of the EMS system begins with the logging of emergency calls and the dispatch of response teams.

People that make use of Rescue911's services include subscribers and non-subscribers. Direct subscribers are individuals or families that subscribe directly to Rescue911 and pay a monthly fee. Indirect subscribers are automatically subscribed to the services of Rescue911 as a result of their medical aid scheme, home insurance or life assurance policies. These medical aid and insurance companies are called providers. The indirect subscribers do not pay the monthly fees, instead Rescue911 recovers monies from their providers by billing the providers directly for the services rendered. Non-subscribers can also make use of Rescue911's services i.e. Rescue911 will respond to all emergency calls received. However, non-subscribers will be billed for any emergency care provided to them.

Rescue911 has seen significant growth in operations in recent years. They currently have 2 million subscribed members (direct and indirect), 2008 revenue was $500 million, and in the first 6 months of 2009 they have responded to 125 000 emergency incidents, an average of 25 emergencies per base station per day.

2.2 Organization Structure

Rescue911 has a flat organizational structure. Beyond the Chief Executive Officer (CEO) there are only three senior managers, the Chief Medical Officer, Chief Operating Officer and the Chief Financial Officer. The responsibility of the Chief Medical Officer is to make sure that Rescue911's dispatching and medical procedures adhere to the expectations of the National Association of EMS Physicians. The Chief Operating Officer is responsible for the day to day business. He is in charge of the call center and all base stations. The call center operators are emergency medical dispatchers certified by both national and international academies of emergency dispatching and have been trained in emergency telecommunications. Rescue911's organizational structure is depicted in Figure 1.

2.3 Problem Statement

The recent growth of Rescue911 has not come without its problems. Rescue911 has begun to receive numerous complaints about their services from subscribers and providers. They are also under increasing pressure from the government, hospitals, doctors, medical aids and insurance companies to properly account for their services. Typical problems include:

- spending too much time monitoring and coordinating response teams instead of focusing on the medical aspects of dispatching,

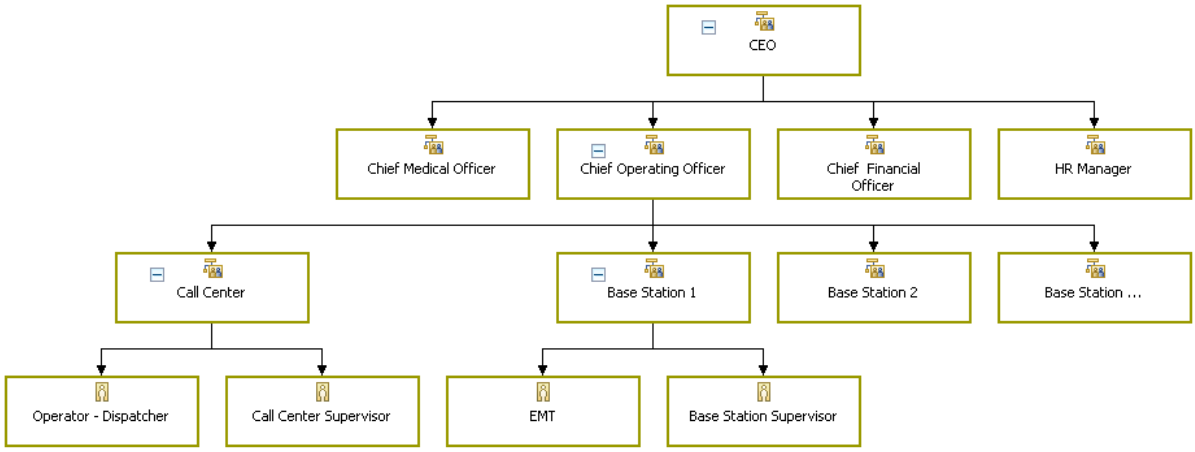

Figure 1: The Rescue911 Organization Structure

- lack of real-time information on EMT and response team availability,
- inability to confirm for callers whether a response to an emergency has been dispatched or to provide details on the response configuration,
- inability to determine which emergency calls have been closed / concluded and which are still in progress,
- under qualified teams are often dispatched and thus EMTs arriving at a scene are not adequately skilled to deal with the emergency situation,
- over qualified teams are being dispatched to non-critical incidents leading to poor utilization of skilled resources,
- lack of proper documentation of services provided at a scene to both subscribers and non-subscribers,
- inaccurate records of shifts worked by EMTs at the various base stations,
- incomplete records of EMTs and their qualifications, and
- lack of metrics for performance management especially in relation to response turnaround times.

Rescue911 management has determined that many of the problems result from inadequate systems that have not kept pace with their growth rate. They aim to solve these problems through the introduction of a new information system. The system is to be called ERIS (emergency response information system).

The new ERIS system is aligned to Rescue911's objective to maintain the infrastructural capacity needed to deliver comprehensive emergency service solutions. Through the implementation of ERIS, Rescue911 management aim to ensure the company can realize its key performance objective to standardize the process of call logging, ensure accuracy of response team dispatching, and improve pre-hospital treatment and customer satisfaction with response performance. The system will also provide for improved internal operational effectiveness, more efficient utilization of response teams, and better management control over base stations.

There will be three users of ERIS:

1. Call Center Operators, the emergency medical dispatchers, who will use ERIS to log emergency call details, dispatch one or more response teams, and follow up on calls dispatched. Supervisors are a type of operator who are also able to deal with those emergency calls to which operators are unable to dispatch a response due to response team unavailability, and to authorize the cancellation of an emergency response
2. EMTs who will report for duty (clock-in) at the beginning of their shift by logging into ERIS and will also use ERIS to input details about patient care provided at emergency scenes
3. Rescue911 managers who will use ERIS to produce certain reports. These reports included demand reports, schedule reports as well as exception reports. Managers are also responsible for maintenance of master file data.

2.4 Functional Requirements

ERIS will be implemented using a phased approach. Based on the needs identified, the following requirements have been defined for inclusion in the first-phase of the ERIS project (see Table 1), while later phases will incorporate billing, accounting and finance, vehicle and asset management, and a mobile, PDA based, EMT-patient care sub-system.

The above requirements will be met through the following four sub-systems:

1. Computer aided dispatch sub-system (CAD) –
   Primary users: Operators and Supervisors
   a. Log emergency calls received
   b. Dispatch, track and manage emergency responses
   c. Reporting and online querying

ID	Description	Source	Kind	VerifyMethod	Risk	Status
1	To log details of emergency calls received.	User	Functional	Test	High	Approved
2	To link emergency calls to an emergency response.	User	Functional	Test	High	Approved
3	To dispatch, track and manage emergency responses.	User	Functional	Test	Medium	Approved
4	To follow-up for callers on the status of an emergency response.	User	Functional	Test	Medium	Approved
5	To record the arrival and departure of a response team from a scene.	User	Functional	Test	Medium	Approved
6	To record EMT's clocking-in and out of shift duty.	User	Functional	Test	Low	Approved
7	To maintain patient care data.	User	Functional	Test	Medium	Approved
8	To maintain response team and EMT staff records.	User	Functional	Test	Low	Approved
9	To maintain records on base stations.	User	Functional	Test	Low	Approved
10	To maintain records on subscribers.	User	Functional	Test	Low	Approved
11	To produce relevant exception, summary and scheduled reports.	User	Functional	Test	Low	Approved
12	To operate the system 24 by 7.	User	Performance	Demonstration	High	Approved

Table 1: Selected User Requirements

2. Base Station management sub-system (BSMS) – Primary users: EMTs and Managers
    a. Base station records management
    b. EMT records management
    c. Response team records management
    d. EMT shift logging (clocking in and out)
    e. Reporting
3. Subscriber management sub-system (SMS) – Primary users: Managers
    a. Direct and indirect subscriber records management
    b. Reporting
4. Electronic patient care reporting sub-system (EPCR) – Primary users: EMTs
    a. Capture patient care data
    b. Reporting

The dependencies between these sub-systems are illustrated in the package diagram see Figure 2.

2.5 Interviews with Stakeholders

Interview with Mr Tye Red, Chief Operating Officer, to understand details related to handling of emergency calls and dispatching of response teams

Q. Please explain the concept of an emergency
A. There are many types of emergencies to which Rescue911 responds. Typical emergencies include: vehicle collisions, heart attacks, strokes, shootings, stabbings, child birth, drownings, allergic reactions, choking, broken bones, and numerous other household accidents and incidents.

Q. What are the responsibilities of operators when answering an emergency call?
A. Rescue911's call center operators are Emergency Medical Dispatchers that possess special knowledge and skills. Dispatchers not only log calls and dispatch response teams, they are also responsible for the medical aspects of dispatching, providing direction and pre-arrival instructions to callers. Through caller interrogation, dispatchers are able to evaluate the severity of the injury or illness, allocate the call to a priority category, and ensure that they dispatch an appropriate response configuration.

Q. How exactly is the priority category determined? And what role would you like the system to play?
A. Operators are highly trained to determine the severity of an emergency and assign the call to a priority category. This function is not required to be automated by the system.

The priority category of an emergency is determined by the dispatcher at the time of the call based on information provided by the caller. Criteria based dispatch guidelines provide a series of well structured questions that operators have been trained to ask of callers. The priority category, and the estimated number of patients involved, determines the response configuration i.e. the number and skills levels of response teams that need to be dispatched.
The priority categories are:

1. Minor incident cases where treatment can be delayed. These are mostly minor single victim / patient accidents requiring basic care levels.
2. Stable cases where single or multiple victims / patients are reported but all are conscious and considered stable. Prompt but basic treatment levels are required.
3. Serious cases when a single or multiple victims / patients are reported and one or more are unconscious or considered unstable due to possible injury to vital points. Prompt and advanced treatment is desirable.
4. Critical trauma cases when a single or multiple victims / patients are reported and one or more are unconscious, not breathing, or have lost a great deal of blood. Prompt and advanced treatment is necessary for patient survival.

Prioritization is core to the effectiveness of the dispatch process to ensure that appropriately qualified teams are dispatched to provide the appropriate level of care.
The dispatching operator needs to input the priority category of an emergency as well as the number of response teams that are required. Operators also need to capture the address, nearest landmark to the emergency, the phone number and name of the caller, and a brief description of the emergency. Once these details of an emergency are captured, we consider the emergency call as being in a 'logged' state. The operator should then proceed to dispatch a new response, or link the call to an existing emergency response.

Q. What do you mean by dispatching a response and linking the call?
A. An emergency call should result in what we term an emergency response. This is the actual dispatching of one or

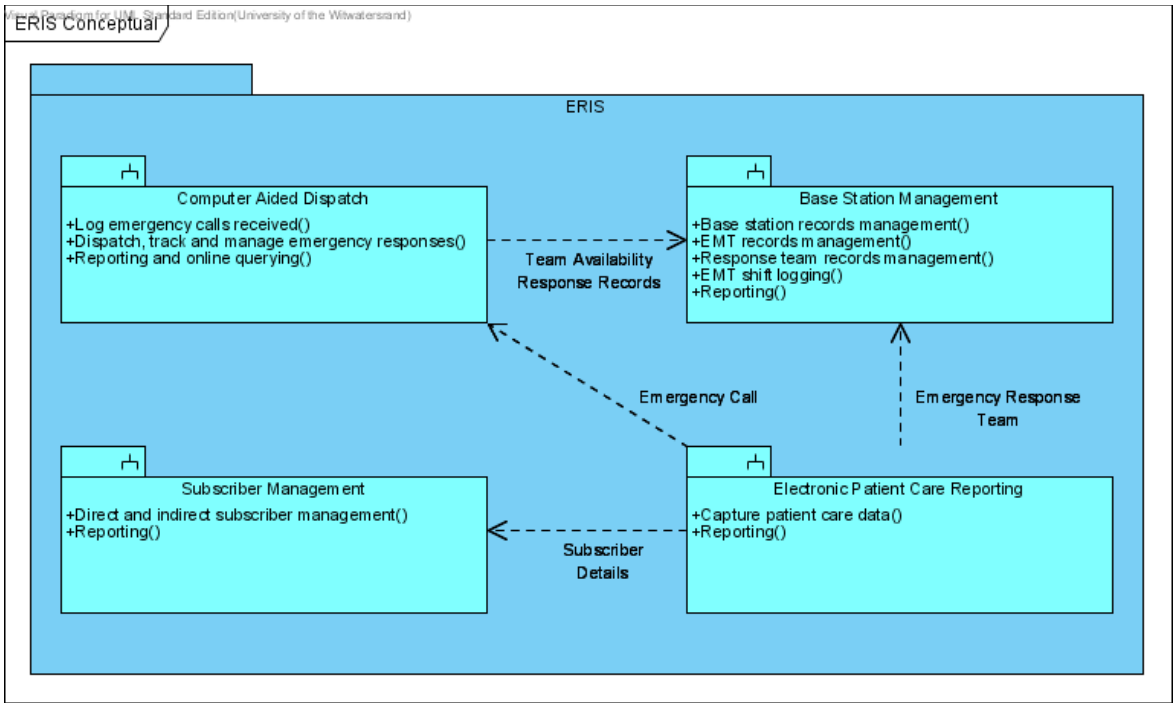

Figure 2: ERIS Package Diagram

more teams of particular skill that proceed to the emergency location in a certain response mode (e.g. red lights and sirens versus routine driving).

Sometimes Rescue911 will receive more than one call for the same emergency situation. Operators will determine if any new calls received are related to existing calls and can then link the call to an existing emergency response. This will ensure that the operator does not dispatch a response to an emergency which is already being dealt with. The operator will inform the caller that Rescue911 is already aware of that emergency situation and that a response team has already been dispatched to that scene.

Obviously this is not a faultless process and we have had situations before where two different emergencies have occurred in close proximity. Operators have incorrectly assumed that callers have been referring to the same emergency situation. Therefore, we would like an operator to be able to refer the details of any emergency situation already recorded so that they can clearly determine from the caller whether the emergency being reported is indeed a new one.

Q. Can you please explain more about the process of dispatching a response team?
A. Response teams are dispatched from one of 25 base stations. Response teams are dispatched based on availability, proximity to the emergency location, and the response team's grade. The new ERIS system does not need to determine which base station is closest to the emergency. Instead, operators already have access to a sophisticated GIS / GPS (geographic information system and global positioning system) that is used to map emergency locations to base stations. When initiating a dispatch for a new emergency response, we'd like for the operator to simply be required to input into ERIS the base station ID of the nearest base station as determined from the GIS / GPS system.

Our GIS/GPS system shows our base station locations, and emergency response flags. Operators use this system to find base stations closest to reported emergency locations. Some of our very experienced operators often know the different areas so well that they can recall by heart the closest base station. We'd like for the new ERIS system to allow operators to use the base station ID in order to begin the process of searching for an available response team.

The operator dispatches a response team by radioing the relevant base station "Control to Base Station AAA. Response Team XXX Proceed to Location XXXXXX. Over"

Once a response team is dispatched, the operator waits for the response team to respond over the radio system with "Roger Control. Response Team XXX Proceeding to Location. Over".

If no response is received within 15 seconds, the operator radios the team again. If no response is received within a further 10 seconds, the operator is required to dispatch another team. The system should enforce this confirmation process i.e. the operator must confirm that a response team has acknowledged the call and that they are proceeding to the scene. Once confirmed, we consider the Emergency Call as having changed from a 'logged' to 'actioned' state, and the system should record that a responding team has been dispatched.

Q. What happens next?
A. The operator will radio a description of the emergency to the responding team. The operator will also request that the

responding team radio in to the control center upon arrival at the scene. The response team will typically call in upon arrival with "Response Team XXX to Operator. Response Team XXX on Location. Respond. Over" Any operator at the control room can then respond "Roger Response Team XXX". This is important step in the process as it allows us to know that a responding team is actually 'on-scene' and the time of team's arrival.

Q. Does the process always run as smoothly as you've described it? Are there any exceptions?
A. Yes, of course there will always be some exceptions. For example, if an operator is attempting to dispatch a response team to an emergency but no teams are available from an appropriate base station, the Emergency Call is flagged as 'waiting'. Dispatch supervisors are responsible for dealing with all calls that are 'waiting'. Usually, the supervisor will attempt to dispatch a team currently in the field by radioing teams close to the scene and determining their availability. Supervisors are able to do this by checking their AVL (automatic vehicle location) and GIS/GPS systems to find teams in the field close to another emergency scene. Our AVL system, lets us know where each responding team is at any point in time.

If a supervisor is able to dispatch a team in the field, then they should do that. If they can't, the supervisor contacts another emergency services company e.g. County EMS. Once the other service provider confirms they are attending to the call, the supervisor closes the call on our side.

Q. What is your expectation with regards to the integration of ERIS with the existing GIS/GPS and the existing AVL system?
A. We don't want you to make any changes to the existing AVL or GIS / GPS system. Their developers (Live Track Inc) will be responsible for integrating them with our new ERIS once it is completed. They will ensure that the AVL system and the GIS/GPS system read data from ERIS in order to update the maps. It is not within your brief to worry about those systems. I only mentioned them so you could understand that those systems also play a role in the overall process.

Interview with Ms Sue P. Phizer, Base Station Supervisor, to understand and clarify the roles of EMTs and response teams

Q. Can you explain to us what an EMT does, and what is a response team?
A. An EMT is a trained emergency medical professional. Within our company, EMTs can be one of three EMT Grades. These are: basic EMT, paramedic, and critical care paramedic. EMTs never work alone. They each belong to what we call a "response team". Each response team will have 3 to 4 EMTs. Each response team is assigned a team grade. The team's grade is determined by the grades of the EMTs that make up the team. The team will be categorized as grade 1 (basic life support team), 2 (advanced life support team) or 3 (critical care team).

Q. Of what importance are these grades?
A. Grades come into play during the dispatch process. I'm sure our COO explained that process to you. I used to work in the control room as a dispatch supervisor before I was promoted to the base station supervisor, so I have a very good idea about how all the pieces fit together. Let me explain: Grade 1, basic life support teams, can respond to emergency priority categories 1 and 2. Grade 2, advanced life support teams, can respond to categories 1, 2 and 3. Grade 3, critical care teams, can respond to categories 1, 2, 3 and 4. Grade 1 teams ride in basic life support ambulances, while grade 2 and 3 teams ride in advanced life support ambulances.

Rescue911's priority dispatch rule is always to configure a response with a team whose grade meets the emergency's priority category rather than exceeds it e.g. for a category 2 emergency, dispatch operators should first try dispatch a team with grade 1, if none are available then try a grade 2 team, if none available then only try a grade 3 team. This is done to ensure that advanced and critical care response teams are reserved for the most serious of emergency priorities.

Q. Can you please explain more about how the shifts work?
A. Response teams work on 1 of 3 shifts. There is a 12am to 8am shift, and 8am to 4pm shift and a 4pm to 12am shift. When EMTs arrive for work, at their shift time, they need to "clock in". Response teams usually have three to four EMTs assigned. If a response team has only 1 team member that has reported for duty on their allocated shift, then that response team cannot be dispatched to any emergency scenes.

Q. It seems that some checks need to be performed when dispatching a team from a base station such as yours to an emergency. Can you clarify?
A. Yes, the procedure from the control room's point of view is to find from the nearest base station, those response teams that are 1) on shift, 2) available for dispatch and 3) are qualified to handle an emergency of the specified priority. But remember what I said earlier, our business rule is to dispatch teams with just the right qualifications, so the operator must dispatch a team with the lowest acceptable grade.

Q. Can you please go back to the concept of a shift so that I understand its implications for team availability?
A. A response team begins and ends a shift in what we call an 'invalid' state. Once two or more members of a response team have checked-in and reported for duty, the team then becomes 'available'. These on-shift teams will change state from 'available' to 'away' multiple times in a single shift. When a response team gets dispatched to a scene and acknowledges their acceptance of the dispatch to the operator, their state changes to 'away'. When the response team leaves a scene, the state changes back to 'available'. There is a further state called 'double-dispatch'. If a team is in the away state and asked to respond to an emergency by a supervisor, their state will change from 'away' to 'double-dispatch' upon their acceptance of the supervisor's order. Only control room supervisors are able to double-dispatch teams in the away state.

When an on-shift response team becomes 'available', at the beginning of a shift, they are assigned a shift grade equal to the value of their team grade. However, in the case of a team whose default is critical care (grade 3), that grade will only be assigned when at least one critical care paramedic has reported for duty. If no members on duty are critical care paramedics then the team will be assigned a shift grade of 2 (advanced life support). Oh, I must clarify! It is the shift grade rather than default team grade that should be used when determining a team's eligibility to respond to an emergency. Please remember that.

Q. OK, so when deciding on which teams to dispatch, the operator should decide based on the grade assigned to an on-shift team, which might be different to their default team grade.
A. Yes. You've got it.

Interview with Dr Warren Piece, Chief Medical Officer, to better understand emergency response procedures

Q. Can you please explain what happens at an emergency scene?
A. With pleasure. Insurance companies and doctors treating patients often require Rescue911 to provide a report on the qualifications of EMTs responding to an emergency call as well as the specific details of emergency care provided to patients at the scene. This information together with information on their average response times may also be requested by various national accreditation bodies when reviewing Rescue911's license to operate as an emergency services provider.

Therefore, at the scene of an emergency, responding EMTs need to record information on emergency care provided including details of procedures as well as medicines administered. Patient vital signs (heart rate and blood pressure) also need to be recorded at the time the EMT leaves the scene or hands the patient over to medical staff at a hospital. Details of the hospital or clinic to which a patient was transported must also be recorded. Currently, we use field notebooks to record all details about procedures and care given to patients.

When we arrive or leave an emergency scene, we always radio in to the operators at the call center to ensure that our movements are recorded. By telling them we're returning to base, they also know that we're available again to respond to other emergency calls.

Q. I'm beginning to get a good picture. As you probably know, in version 1 of ERIS, all data to be recorded by EMTs will be done at the base station. So your field note books will still be necessary for now, and you'd need to transcribe from those field note books to the ERIS system upon arrival back at base.
A. Yes, we do understand. In fact I brought along a copy of the field note book to show you.

Q. But we are very excited about Version 2 of ERIS which will enhance the EPCR sub-system by rolling out handheld devices that will replace the field note books. Is there anything else at this stage that you would like to tell us?
A. I think we're done. I'm holding thumbs for a smooth implementation.

Interview with Mrs Ima Cranky, Chief Executive Officer, to understand managerial reporting requirements

Q. What types of reports does management need from the new ERIS?
A. The first thing that is very important to us, is that an exception report should be printed at the end of each shift of all emergency responses that are not yet closed and the details of the emergency calls to which they have been linked. The manager requesting this report is the call center supervisor. He/she will follow up and radio response teams, if necessary, to determine the situation before handing the call center over to the next supervisor.

Another exception report is needed by base station supervisors of patient care records not yet captured by the responding EMTs.

A scheduled report must be produced each week. The report will indicate for each base station and for each shift, which EMTs had reported for duty. Our accountant will use this report to prepare the weekly EMT paychecks.

Our COO will need a weekly summary report of the number of emergency responses attended to by each base station that week. This report allows us to make important decisions about our capacity to handle emergencies in the different locations.

Medical aid and government regulation requires that Rescue911 is able to report on our emergency responses. If necessary, on demand, our CMO will need to be able to produce a report on the details of an emergency response, including: the time the call was logged, details of response configuration dispatched from base stations, the response mode, the time of arrival on scene, the treatment given to patients, the hospital to which they were transported, and the time, and by whom, the response was finally closed on our side.

3. STUDENT REQUIREMENTS

The following milestones or deliverables are suggested to be delivered by students:

Milestone	What students will produce
1: Team Project File	Team will create a professional project file with name, logo, and relevant milestone sections
2: Value chain / Business Process	This milestone requires the students to contemplate the value chain of an emergency services company (based on an internet research about existing companies) and the major business processes executed in conducting the business. One major business process has to be mapped and consideration has to be taken in identifying manual processes, automated processes and business rules. Suggested solutions are provided in the teaching notes.
3: Activity Diagrams	Given the complexity of Rescue911's operations this deliverable provides students an opportunity to apply their skills in

Milestone	What students will produce
	process modeling. The milestone also provides students an opportunity to better understand the system's requirements. Suggested solutions are provided in the teaching notes.
4: Use Case Diagrams and Descriptions	Students apply their knowledge of functional modeling to produce use case diagrams and descriptions. The case provides an opportunity to explore both <<includes>> and <<extends>> association types. Suggested solutions are provided in the teaching notes.
5: Domain Class Diagram	Students produce an analysis class diagram focusing on the problem domain. Teaching notes provide suggestions on attributes that can be articulated to students prior to the preparation of the diagram. The case allows for all types of associations including the use of association classes, composition, aggregation, and inheritance hierarchies to be explored. Suggested solutions are provided in the teaching notes.
6: Database Design	The class diagram will be mapped into a fully normalized entity relationship diagram (ERD) / relational database schema. The database should be implemented in an appropriate RDMS. Attention should be placed on the identification of appropriate primary keys, the implementation of relationships through the use of foreign keys, appropriate specification of data types, and the implementation of referential integrity. Tables should be populated with test data.
7: Screen Design	An initial design of screens, a windows navigation diagram, menu matrix and user roles. Students should design the screens using a visual IDE such as Visual Studio.
8: Class and Method Design	Interaction diagrams (such as sequence diagrams) should be developed. Students should harvest the methods from the sequence diagrams to produce a design level class diagram.
9: Architecture Design	An optional milestone for a more technical class. This milestone provides students an opportunity to reflect on the underlying technology layer for the ERIS system. It is suggested that the implementation of the system is required on a 3-tier, web-based architecture (browser based client, web / application server (business logic) and database server).
10: Individual Programming Deliverable	The case is broad enough to allow each individual in a team to take responsibility for designing a program, preparing a test plan, and then coding part of the system's functionality. This deliverable will test each individual's ability to adhere to the team's input design conventions, code in their choice of language, and read/update records to the backend database. An optional add-on is the integration of the geographical tracking of the available teams (via integration of internet-based geographical map provider).
11: Final Delivery	Teams will need to integrate individual programs and test their systems. They should present their systems in the form of a walk through. Final documentation in the project file, as well as user manual and training plan should be delivered and must be professionally presented. An implementation and change management plan should also be required.

4. ACKNOWLEDGEMENTS

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All UML diagrams presented in the teaching notes were created with Visual Paradigm Standard Edition V7.0. The software is used in teaching object-oriented analysis and design. The organization chart and business processes were created with IBM Business Modeler Advanced V6.2.

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