Advanced Protocols via Emergence for Ad hoc Networks

1. Research Objective

The objective is to produce a protocol for ad hoc networks of the future via emergence. Such a protocol needs to accommodate scenarios which can not be premeditated prior to deployment. This involves the creation of an 'alphabet' from the characteristics of existing protocols with methods for combining the letters in it.

2. Future of Ad hoc Networks

An ad hoc network is characterised by devices connected in an arbitrary manner to form a network without a central controller. Ad hoc networks of the future must interconnect applications such as home robots, wearable computers, and sensor networks. To succeed they must be self-organised and display characteristics of emergence, robustness, adaptability and scalability.

3. Protocol Stack

Communicating between devices involves layers of interacting processes, from the transmitting radio waves to the user software such as a web page. These combined layers are called a protocol stack.

A standard model of a protocol stack is the OSI model. Each layer can contain one or more different sub-protocols. Protocols today generally use a subset of these sub-protocols and are fixed for a particular type of application.

Applications And Middleware	Application Layer	
	Presentation Layer	
	Session Layer	
Networking	Transport Layer	
	Network Layer	
Enabling Technologies	Data Link Layer	control
		MAC
	Physical Layer	

OSI Model

4. Characteristics and Protocol Mapping

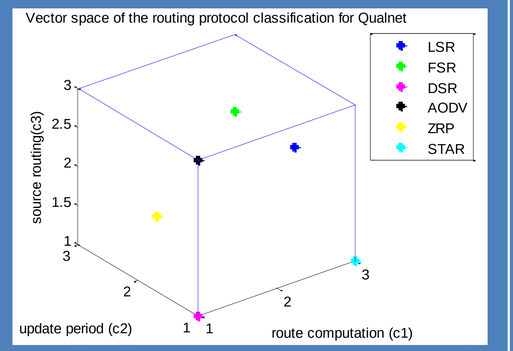
Each layer within the protocol stack is defined by a number of characteristics. For example, routing sub-protocols can be classified using three orthogonal characteristics, or three 'alphabet' letters and can be modelled as a 3D vector space. Each protocol can be mapped to a point in the vector space defined by a scale along each characteristic.

Route Computation		
(1) Reactive	(2) Hybrid	(3) Proactive

Update Period		
(1) Event	(2) Hybrid	(3) Periodic

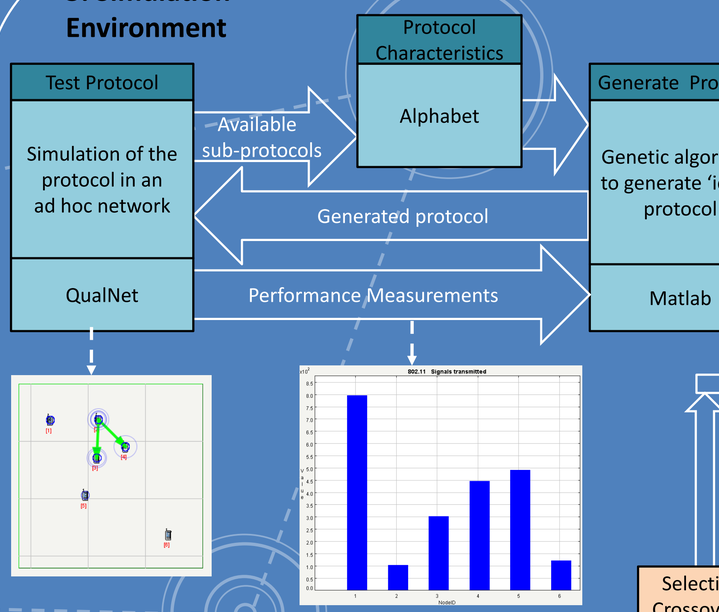
Source Routing		
(1) Source	(2) Hybrid	(3) Hop

Characteristic scale

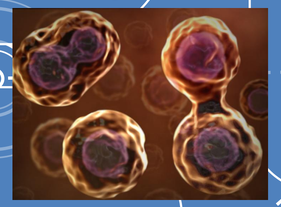


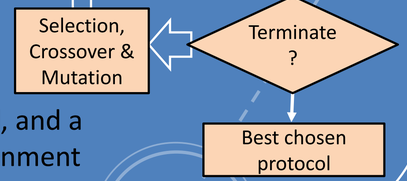
A genetic algorithm is used to identify a point in the vector space that is considered to be the best guess of the routing protocol characteristics under the current network conditions. This is then mapped to the closest available routing protocol . Each layer of the protocol is built up in this way.

5. Simulation Environment



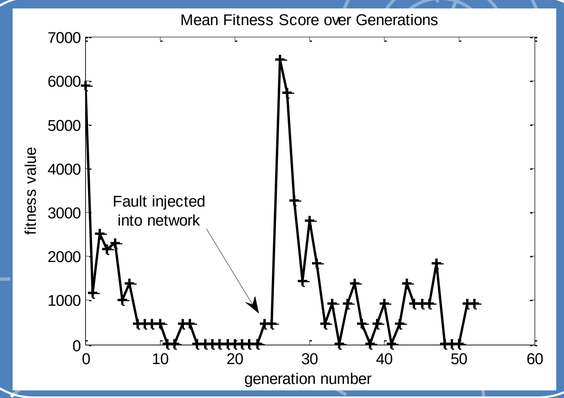
The full simulation environment uses Matlab to Run a genetic algorithm to find the 'ideal' protocol, and a simulator to simulate the ad hoc network environment and extract performance measurements.





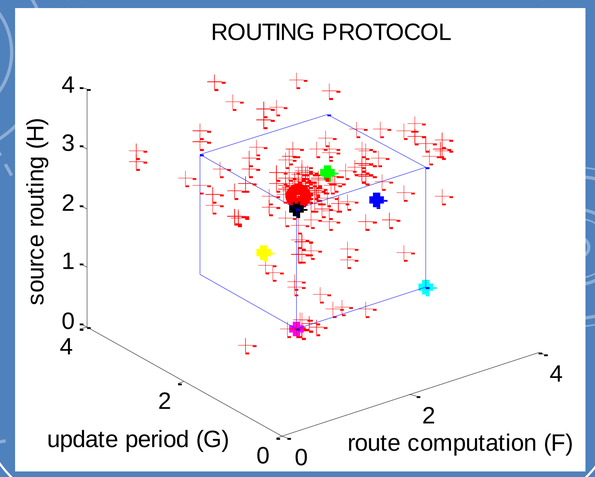
6. Genetic Algorithm

A genetic algorithm is used to find an optimum solution by minimising a simple fitness function. An initial population of N random protocols are simulated in turn, each returning performance measurements, then processed by the fitness function to obtain a 'fitness score'. Selected 'fittest' protocols undergo crossover and mutation to create a new population. This is repeated until an optimum solution is found.



7. Optimum Protocol

Optimisation of the routing protocol under a particular network scenario found AODV (Ad hoc On-demand Distance Vector) to be the fittest.



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