

undefined future space applications. Having performed simulation of a new link, implementation of that link can be set up on demand, using optimised parameters which are based on the simulation results. The facility provided by the embodiments of the present invention can be used during the implementation and operating phases of such space communications projects, either to verify predictions against actual measurements, or as a diagnostic tool in case of any anomalies.

Summary of Invention

According to aspect of the present invention, there is provided an apparatus for the optimisation of a constellation of a constellation of communications assets comprising a first system for interfacing with a user to receive a specification of communications assets to be tested for assembly as a constellation from the user, and for selecting one or more modules for modelling properties of the specified communications assets, a second system arranged to interface with the first system and configured to combine properties of the specified communications assets, to model a constellation of the specified communications assets, a third system arranged to interface with the second system and configured to determine whether the modelled constellation is operational when one or more conditions are imposed on the availability of one or more of the communications assets and a fourth system arranged to interface with the third system, and for simulating and optimising the performance of the constellation if the constellation is determined to be operational by the third system by applying one or more test scenarios to the modelled constellation, and for outputting the simulation results to the user.

The first system may comprise the one or more modules for modelling properties of the specified communication link.

The one or more modules in the first system may be implemented in hardware and/or software and are interchangeable.

The selection performed by the first system may be of one or more modules representing independent off-the-shelf assets.

The fourth system may be arranged to output link quality parameters for the communications constellation.

The simulation results may be provided to a user via a user interface, and the user interface may also be arranged to receive the specification of the communications

The fourth system may be arranged to receive a user instruction to establish a simulated communications link and to interface with external systems and to use information in the one or modules of the first and second systems to transmit an instruction to external software and/or hardware to establish the requested communications link.

5

The third system may be arranged to test connectivity within the constellation by determining whether end-to-end links can be achieved technically, and achieved in view of constraints imposed on the modelled constellation, in which the constraint data may represent user-defined regulations and physical restrictions.

10

The third system may be arranged to provide a visual representation of the modelled constellation to the user and to provide orbital handover, viability and constraint data to the fourth system.

15

According to a further aspect of the present invention, there is provided a method of optimising a constellation of communications assets, comprising receiving a specification of communications assets to be tested for assembly as a constellation from a user, selecting one or more modules for modelling properties of the specified communications assets, combining properties of the specified communications assets to model a constellation of the specified communications assets, determining whether the modelled constellation is operational when one or more conditions are imposed on the availability of one or more of the communications assets, if the constellation is determined to be operational, applying one or more test scenarios to the modelled constellation to simulate and optimise the performance of the constellation, and outputting the simulation results to the user.

20

25

The method may be implemented as a computer program.

30 **Brief Description of Drawings**

Embodiments of the present invention will now be described by way of example only, with reference to the accompanying drawings, of which:

Figure 1 is a schematic of an apparatus for simulating and optimising the performance of a communications constellation according to an embodiment of the present

35

invention;

Claims

1. An apparatus for the optimisation of a constellation of communications assets, comprising:

a first system (20) for interfacing with a user to receive a specification of communications assets to be tested for assembly as a constellation from the user, and for selecting one or more modules for modelling properties of the specified communications assets;

a second system (30) arranged to interface with the first system and configured to combine properties of the specified communications assets, to model a constellation of the specified communications assets;

a third system (36, 37) arranged to interface with the second system and configured to determine whether the modelled constellation is operational when one or more conditions are imposed on the availability of one or more of the communications assets; and

a fourth system (40) arranged to interface with the third system, and for simulating and optimising the performance of the constellation if the constellation is determined to be operational by the third system by applying one or more test scenarios to the modelled constellation, and for outputting the simulation results to the user.

2. An apparatus according to claim 1 wherein the first system (20) comprises the one or more modules for modelling properties of the specified communications assets.

3. An apparatus according to claim 2 wherein the one or more modules in the first system (20) are implemented in hardware and/or software and are interchangeable.

4. An apparatus according to any one of the preceding claims wherein the selection performed by the first system (20) is of one or more modules representing independent off-the-shelf assets.

5. An apparatus according to any one of the preceding claims, wherein the fourth system (40) is arranged to output link quality parameters for the constellation.

6. An apparatus according to claim 5, wherein the simulation results are provided to a user via a user interface (50), and the user interface also arranged to receive the specification of the communications assets from the user,
wherein the user interface contains a number of input elements (52, 53, 54, 55) for varying the properties of the constellation to be modelled, and a component (51-e) for updating, substantially in real-time, the simulation results as the input elements are varied.
7. An apparatus according to any one of the preceding claims, wherein the fourth system (40) is arranged to simulate communications performance and/or network management tasking.
8. An apparatus according to any one of the preceding claims, wherein the second system (30) is arranged to convert properties of the specified communications assets to a common domain and normalise parameters associated with the properties of the specified communications parameters in the common domain.
9. An apparatus according to any one of the preceding claims, wherein the one or more test scenarios are stored in a module (41) in the fourth system (40), and the first system (20) is arranged to receive a user specification of the one or more test scenarios to be applied to the simulated constellation.
10. An apparatus according to any one of the preceding claims, wherein the one or more modules of the first system (20) store data modelling one or more of:
 - end user terminal types;
 - channel matrices;
 - multipath interference effects;
 - handovers between ground stations and/or satellites and/or user terminals;
 - inter-satellite links;
 - application types to be communicated in the simulation;
 - radio-link budgets;
 - spectrum availability;
 - communication protocols;
 - encryption requirements; and
 - air interfaces;

wherein the one or more modules are selected for modelling properties of the communications assets by extracting properties from the specified communications assets and selecting the one or more modules which contain data modelling the extracted properties.

11. An apparatus according to any one of the preceding claims, wherein the fourth system (40) is arranged to receive a user instruction to establish a simulated communications link and to interface with external systems and to use information in the one or modules of the first and second systems to transmit an instruction to external software and/or hardware to establish the requested communications link.

12. An apparatus according to any one of the preceding claims, wherein the third system (35, 36, 37) is arranged to provide a visual representation of the modelled constellation to the user and to provide orbital handover, viability and constraint data to the fourth system.

13. A method of optimising a constellation of communications assets, comprising:
receiving a specification of communications assets to be tested for assembly as a constellation from a user (S10);

selecting one or more modules (S40) for modelling properties of the specified communications assets;

combining properties of the specified communications assets to model a constellation of the specified communications assets (S50);

determining whether the modelled constellation is operational when one or more conditions are imposed on the availability of one or more of the communications assets (S70, S80, S90);

if the constellation is determined to be operational, applying one or more test scenarios to the modelled constellation to simulate and optimise the performance of the constellation (S100); and

outputting the simulation results to the user.

14. A computer program, which when executed by a processor, is arranged to perform the method of claim 13.