INTEGRACE ATN SLUŽEB NA DRUŽICOVÝ SYSTÉM

INTEGRATION ATN SERVICES ON SATELLITE SYSTEM

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Anotace: Družicový system sa stáva nedelitelnou součástí přenosových systému pro letectví. Článek popisuje základní přístup k integraci ATN služeb do družicového systému.
Klíčová slova: ATN, družicový system, avionický system
Summary: The satellite component is expected to operate alongside that of the terrestrial component and provide a complementary rather than a competitive service. In this paper, the requirements of inter-working and integration of these networks are discussed at different levels.
Keywords: ATN, satellite system, avionics system

1. INTRODUCTION

Satellite service types may be divided into sub-services according to the following classification:

- fixed satellite services – fixed satellite services concern all radio communication services between earth stations at given positions that can be at a specified fixed point or any fixed point within specified areas. The following basic types of users are identified:
    - fixed within local broadband locality access remote broadband locality through areas with satellite coverage only,
    - access services within satellite coverage only,
    - access a remote broadband locality from areas with satellite coverage only.
- mobility satellite services – mobile satellite services include all radio communications between a mobile earth station and the space station or between mobile stations via one or more intermediate space stations. The following basic types of users are identified:
    - alternative from one cellular locality to another via areas with satellite coverage only (using trains, aircraft or ships) (*local radio link*),
    - moving within satellite coverage only,
    - alternative from cellular locality to areas with satellite coverage only.

2. SERVICE INTEGRATION ASPECTS

A satellite-based system has inherent capabilities of providing multipoint and broadcast transmission, connectivity between any two distant nodes within a wide-area coverage, quick network configuration and reconfiguration, rapid allocation of space segment capacity and distance-insensitive costs. With the increased communications requirements in business networks for multimedia services three generic mobile multimedia service types may be considered:

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- asymmetric band for multimedia,
- asymmetric band (large) for multimedia,
- symmetric band for interactive multimedia.

The key drivers that are likely to affect development of the mobile multimedia market are:

- growth in communications, commerce and entertainment services in the fixed network,
- demand for rapid, remote access to information.

Several satellite systems are already providing services specific of the space environment:

- positioning systems for general applications – GPS,
- location at ground level for fleet management,
- voice and data communication,
- radio-navigation systems,
- weather display,
- aeronautical communications and direct passenger telephone, satellite messaging for commercial jetliners,
- paging systems used on truck,
- emergency-distress services for rescue operations,
- etc..

The most significant attribute of a satellite communication system is the wide area coverage that can be provided with very high guarantees of availability and consistency of service. Three levels of integration between satellite and terrestrial networks:

- service integration,
- network integration,
- system integration.

Some of the new problems that need to be dealt with include:

- satellite/network resource management,
- handover strategies,
- mobility management,
- optimum use of control channels,
- optimum fixed ground network configuration to support the set of satellites, minimizing terrestrial backhaul costs,
- optimum routing and configuration management of traffic,
- optimum use of inter-satellite links in conjunction with the ground network,
- security and authentication in this world-wide system,
- power, frequency, timing and synchronization control and management,
- terrestrial network interfaces,
- combined satellite and terrestrial networks to provide optimum performance for a variety of existing and new services.

Three classes of satellite systems for fixed/mobile users:

- transparent bent pipe satellite,
- advanced fixed/mobile satellite systems using on-board processing (OBP) techniques and inter-satellite links (ISL-s), but most control functions are performed in the fixed earth station (FES-s),
- intelligent mobile satellite systems with enhanced on-board switching, routing and control capabilities.

3. SATELLITE INTERCONNECTIONS

In order to guarantee connections between users not simultaneously visible by the same satellite and at the same time, to avoid a high number of gateways spread over the service area, direct satellite-to-satellite interconnections could be alternatively considered. Advantages and disadvantages of ISL-s are summarized below:

- advantages of ISL-s:
    - routing traffic in the sky independently of the ground infrastructure,
    - a reduction in ground-based control may be achieved with on-board base-band switching reducing delay – autonomous operation,
    - single network control centre and earth station,
    - calls may be routed to the optimal ground station through another satellite for call termination, reducing the length of the terrestrial tail required,
    - increased global coverage such as oceans and areas without earth stations,
- disadvantages of ISL-s:
    - increased complexity and cost of the satellites,
    - power available for the satellite/user link may be reduced,
    - handover between satellites due to inter-satellite dynamics needs to be considered,
    - replenishment strategy,
    - frequency co-ordination,
    - cross-link dimensioning.

Along with safety, the avionics subsystem must also possess sufficient security provisioning for a successful deployment. Adoption of open standards for data networks has further increased the security concerns. In addition, care must be taken about security requirements while achieving interoperability between various systems within the airplane.

In any network system, there are three basic security requirements that need to be addressed. They are confidentiality, authentication and integrity. Data confidentiality ensures the privacy of the end users and protects their data from spoofing. Similarly data integrity ensures that the data sent by the end user is not modified by any malicious element in the network. Authentication is one of the most important factors in network security as it controls access to the network resources. Authentication ensures that only valid users have access to the network resources.

In addition to the above requirements, an airplane network needs additional security in terms of separation between various network segments. The control network has to be protected from unauthorized access. The requires the control network to be separated from the passenger network. Also the passenger network resource usage needs to be monitored and controlled. This requires the passenger network to be connected to a gateway that performs both the monitoring and controlling function in addition to providing Internet access.

The main requirements of the avionics subsystem are high determinism and low response time. Different layer 2 technologies like Ethernet, ATM, fiber channel could be considered to provide such a high determinism and low response time. Ethernet is one of the strongest contenders for connections between various flight sub systems and is also mentioned in standard.

Security and quality of service are the two important parameters that need to be considered while designing the aviation data networks. The quality of service here does not reflect the quality of service requirements of the end-user applications, but it represents the requirements of the avionics subsystem itself.

One of the major security requirements of aviation data networks is the separation of different network subsystems. An aviation data network could possibly contain three major network segments namely a control network, crew network and passenger network. As the names suggest, the control network predominantly consists of avionics components. The crew network is used by the flight crew for monitoring purposes and the passenger network enables internet connectivity for the passengers.

In order to protect the control network from unauthorized access and security attacks, it is necessary that the control network is separated from rest of the aviation data networks. The separation can either be logical or physical.

The network activity monitoring/controlling server could be built in line with an intrusion detection system (IDS). However, unlike normal IDS, the network activity monitoring/controlling server can make decisions based on the data feed from many sources including the cabin voice recorder and surveillance equipment placed at strategic locations within the flight. The server could potentially control all the active forwarding devices. Depending upon the network activity and the security status of the aviation data network, the server can reconfigure the active devices and facilitate control network traffic during emergency situations.

A combination of different layers of satellites can provide a more efficient network with better performance then these layers individually. The core grid layer is formed by the satellites situated at MEO and GEO constellation, in which the function of core and switching as well as the access are implemented. An intelligent access grid layer is formed by LEO satellites, in which the function of CAC (*Connection Access Control*) is implemented. A communication link must be available between any adjacent nodes.

Satellites in the same layer are connected to each other via inter-satellite links (ISL-s), while the communication between different layers is accomplished over inter-orbital links (IOL-s). The sources and destination of information are assumed to be gateways on the Earth. Satellites communicate with terrestrial gateways through user data links (UDL-s). Each link in the network is associated with *delay* and *cost* metric. The delay of a link includes processing, propagation and queuing delays. The cost of the link is related to the available bandwidth and the type of the link in the satellite network.

4. CONCLUSION

Policy-based management is likely to serve as a key integration technology for end-to-end ATN management and also for telecommunication network. Activity policy is a relatively new research area, which is to be explored in a coming few years.

The new system gives the following advantages:

- many functions can be integrated into the multiprocessor system for optimum cost effectiveness,
- modular design allows flexible addition of components with minimum of expenses for extra hard/ or software,
- redundancy can be incorporated simply and inexpensively,
- high reliability,
- etc..

Data network enabled aircrafts have opened up a new set of service opportunities. At the same time, they have also introduced several security threats that need to be addressed. These security threats can originate from outside the airplane or from within the plane.

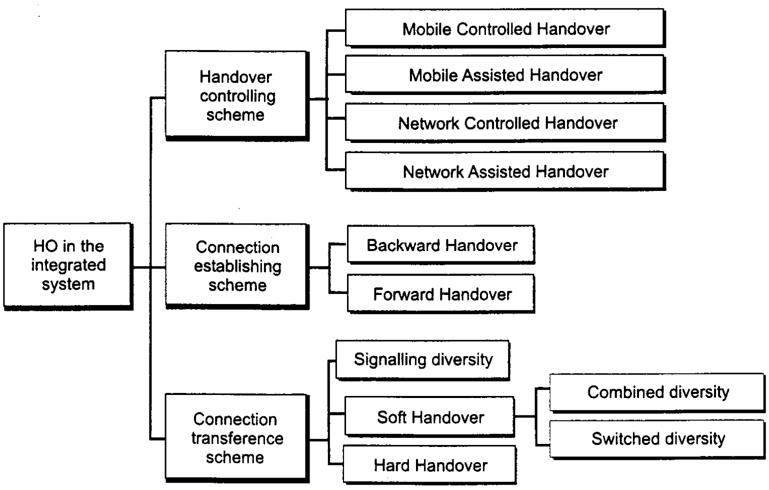

Fig. 1 - Handover taxonomy for satellite/terrestrial network architecture

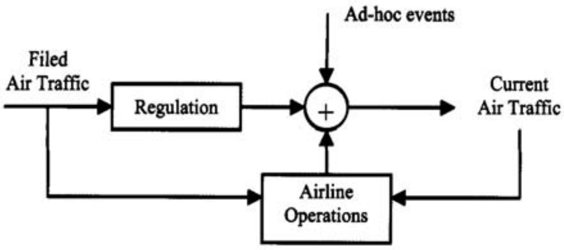

Fig. 2 - Airline operation effect on ATFM

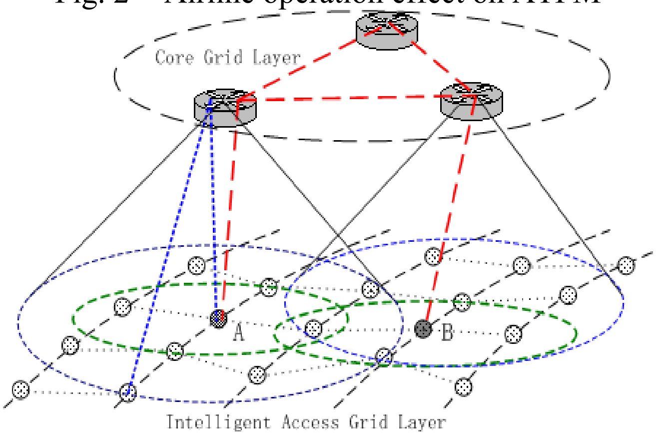

Fig. 3 - Hierarchal three-dimensional architecture of satellite-based system

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