SMART NETWORKS

ATM-GRADE NETWORKS

Network infrastructure is the enabler of future ATM concepts. Only an end-to-end network design that delivers ATM-grade safety and performance enables the industry to achieve expected performance gains and cost reductions

Stefan Galler, product manager ATM network solutions, Frequentis AG

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Flexibly matching demand with supply is the biggest challenge in ATM. It is the core element to achieving the ambitious goals of the industry around the world.

In 2012 the European Commission set high industry expectations: enable a three-fold capacity increase combined with a factor of 10 safety increase, while cutting costs in half by 2020. NextGen, a similar initiative in the USA, asks for safety and efficiency benefits by focusing on performance-based navigation, surface operation, multiple runway operation and data communication.

System-wide information sharing and decoupling of operational and geographic entities by means of virtual centers and remote towers are key elements to achieving the necessary performance, safety and efficiency objectives. The underlying network infrastructure enables these concepts and applications. But they all have different performance, safety and security requirements that need to be considered in an ATM-grade network.

System Wide Information Management (SWIM) is the means for sharing information among all aviation stakeholders. Moving from a product-centric to an information-centric aviation system increases end-to-end efficiency. On the other hand, the information sharing has to be enabled by an underlying ground-ground connectivity infrastructure. Since SWIM deals with fundamental safety-critical information and is open to many stakeholders, a holistic security concept is required.

The virtual centers concept focuses on the decoupling of geographical flight areas and locations from which the operational service is provided. It breaks up the hardware-focused installations in centers and tower deployments by moving applications into a network-centric deployment – the ATM cloud. A radio is represented through a software-based frequency service hosted somewhere in the network infrastructure rather than the physical radio. Smart client-based controller working positions (CWPs) connect to the frequency services they need for their operation. The geographic location of all services and CWPs is flexible and driven by business rather than technical aspects. The underlying network needs to provide high availability at a reasonable price to achieve the expected cost-savings and efficiency gains.

Remote towers enable ANSPs to offer ATC service remotely. This remote operation requires access to information and resources. The virtual center concept enables the remote towers. In addition, a visual video stream from the remote airport is required at the center. Safety and security are especially important. Different network performance demands for voice, data and video streaming, and the need for clearly defined contingency scenarios, require a properly designed network. Only a smart end-to-end design will deliver cost savings.

Independent of the application, end-to-end communication relies heavily on performance of the wide area network (WAN). The WAN service providers invest a lot to maintain and keep the backbone infrastructure up-to-date. To protect this investment they hide the internal network architecture as much as possible. Furthermore, standardized service level agreements (SLAs) ensure a constant revenue stream. But these agreements are static and do not describe the actual network performance at any given time. ANSPs have little knowledge of how the WAN operates, but heavily depend on its performance.

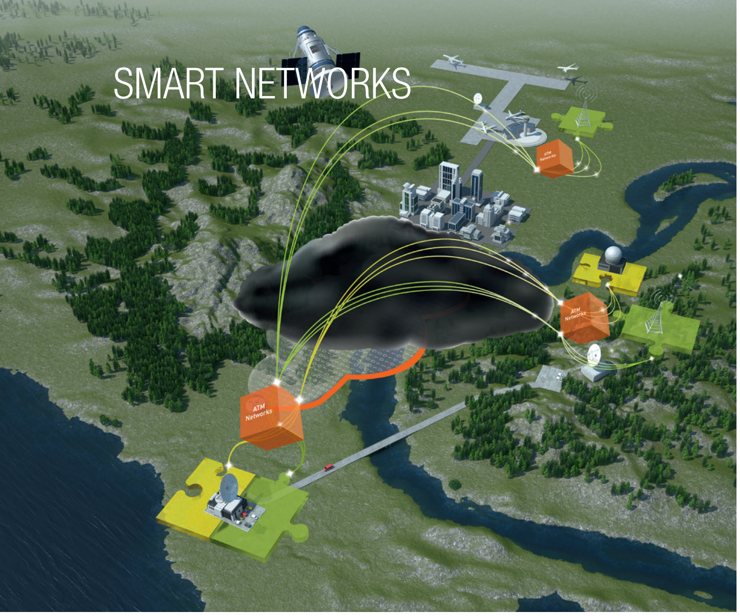
In ATM, conventional networks do not deliver the necessary performance. Rather, we need an ATM-grade network infrastructure. We consider a network to be ATM-grade if it:

- Uses real-time information of the actual network performance to reroute safety-critical communication flows before the link is completely down;
- Enables deterministic behavior to ensure that safety-critical high-priority communication flows get the necessary end-to-end network performance in the event of limited resources; and
- Provides information security of relevant data and business continuity for safety-critical communications.

Benefits of a smart design and routing mechanism

A smart network solution saves operational costs while increasing safety. Operational costs can be reduced through a combination of diverse backbone networks. The network costs depend on the defined SLA. Availability of the network link is a major cost driver. There are two options to achieve the necessary availability: ask one network provider to deliver the requested high availability, or combine two networks with lower availability. By smart end-to-end network design of the latter, the SLA for each network can be relaxed, therefore reducing costs.

Operational voice communication requires 99.9999% availability. Frequentis ATM Networks achieves this by combining two networks: one from provider A and one from provider B. The two networks offer an availability of, for example, 99.95% and 99.8%. The former has strong SLAs and is therefore more expensive, whereas the latter has weaker SLAs



ATM Network provides deterministic routing based on real-time network performance capabilities

and is cheaper. Together they are less expensive than requesting six-9 availability from a single provider.

Each network delivers different performance, which may vary over time. Standard network algorithms work on a binary decision system, such as 'OK' and 'not OK'. In real life, the network state can be everything between these extremes.

Actual weather conditions change available bandwidth on a VSAT or microwave link and the actual communication load on the IP infrastructure produces delay variation. Therefore mechanisms need to be applied to increase availability of the services. Frequentis ATM Networks integrates multiple backbone technologies with a smart routing mechanism to achieve ATM-grade availability for dedicated applications. The solution measures the actual network performance periodically. The ATM-grade routing algorithm considers the actual end-to-end delay, jitter and available bandwidth.

For example, networks A and B provide constant end-to-end delays of 45 and 40 milliseconds respectively between Rio de Janeiro and Recife. Due to heavier rain in Recife, the end-to-end delay on network B increased in the last measuring interval to 70 milliseconds. Following this the Frequentis ATM-grade routing decides to reduce the load on network B by moving safety-critical traffic to network A. This rerouting ensures business continuity for the safety-critical applications and stabilizes the end-to-end performance of network B.

How is safety ensured?

Two important aspects of safety are availability and determinism. High availability can be achieved by the smart combination of two or more backbone networks as explained in the previous section.

Safety-critical applications require deterministic behavior with clearly defined algorithms and parameters. The Frequentis ATM-grade router has built-in knowledge of ATM applications and use-cases. Furthermore, it uses interfaces to specific applications. This knowledge is used to identify the current network performance needs for ATM applications. A deterministic algorithm assigns the available network resources, including performance, to the requesting applications.

For example, the voice communication system requests network performance for two radio calls in addition to three already ongoing non-operational telephone calls. Networks A and B currently offer enough bandwidth for one radio call and one phone call each. The Frequentis ATM-grade routing therefore assigns one radio call and one phone call to both network A and network B. The non-operational phone call with the lowest priority receives a busy signal. This ensures high voice quality for all established calls and results in a deterministic behavior for the network and all applications. Without the deterministic router, all calls would have been established despite insufficient bandwidth. Random voice packets would then have been lost, decreasing voice quality and safety performance.

What are the necessary security means?

A holistic approach considering security and safety is necessary. This end-to-end approach needs to consider corporate processes, system architecture and security appliances. Based on an in-depth analysis of all safety- or security-relevant assets, the possible threats and their impacts on operations are identified. The necessary countermeasures vary for different applications.

Consider the different security aspects of flight plans, customer payment data and operational voice communication. The integrity of flight plan data is more important than preventing access to it. The reasoning is straightforward: as long as it can be assured that the flight plan is not changed, little harm can come from the knowledge of flight plans since they are public knowledge.

Operational voice communication needs business resumption plans rather than information security. Operational voice in civil ATM is transmitted unencrypted on the ground-air interface; the information is therefore public as soon as it enters the air. But it is highly important for safe operations that concepts are in place for business resumption in the event of security attacks that prevent communication or manipulate it.

Nevertheless all operational and process concepts need to be supported by the underlying technology. Therefore Frequentis network architectures consider security zones with diverse vendor solutions. Combining multiple diverse vendors in a smart end-to-end network design has two main advantages:

• It increases availability, since the likelihood of the same failure occurring in two diverse systems is lower than in two identical systems;

• It increases security since an attack on vendor's system is unlikely to work in the second vendor's equipment.

For example, a smart end-to-end network design uses different vendor equipment for the two redundant network paths between locations such as Mexico City and Puebla. If an attacker exploits a bug in one vendor's equipment, the second path is still secure.

To achieve these benefits and the increased resilience of the overall system, Frequentis considers them in its end-to-end design based on long experience and best practice from all safety-critical domains.

Operating multiple applications with different availability and performance requirements is challenging for every ANSP. Based on decades of experience in designing, delivering and operating safety-critical networks, Frequentis provides an ATM network product and solutions portfolio that delivers an ATM-grade infrastructure.

The Frequentis ATM Network solution enables future ATM concepts such as SWIM, virtual centers and remote towers. The high-availability design, combined with the ATM-grade routing, delivers the necessary safety performance increases while realizing cost reductions. ❖