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## A Conversation With...

Giovanni Bisignani
director general and CEO
International Air Transport Association

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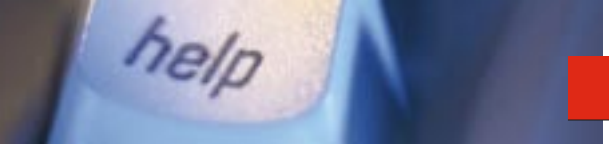




## Talking Technology With …

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# New Technology to Better Automate Schedule Generation

*A new solution can help airlines accomplish large-scale schedule changes that result in the most profitable possible outcome.*

The global airline industry has been transformed into a rapidly changing landscape with new competitors entering markets and other competitors leaving markets or changing service frequencies on very short notice. Airlines need to constantly evaluate the changes in competitors' schedules and, if necessary, adjust their own schedules accordingly. Schedule adjustments may range from a simple flight re-timing over a change in service frequency to a complete hub or even network restructuring.

Today, airline schedulers have tools, such as *Sabre® AirFlite™ Profit Manager* and the *Sabre® Planet®* profitability forecasting system, to measure schedule profitability. These tools are used in concert with fleet assignment models such as the *Sabre® AirFlite™ Fleet Manager* to aid in the schedule design process.

These procedures have led to the development of new product features such as the incremental mode in *Profit Manager* and the drop support mode in *Fleet Manager* that support the schedule-design process. The incremental mode in *Profit Manager* estimates the impact of schedule changes on profitability. The drop mode in *Fleet Manager* enables a scheduler to pass an overbuilt schedule to the system. *Fleet Manager* assigns fleets to as many flights in the schedule as possible and automatically deletes the least profitable flights. The current approach works well for small schedule changes. However, there are several limitations when it comes to large-scale schedule changes, including:

- The identification of possible schedule changes and their incorporation into the existing schedule is done manually. Analysts do not have time to evaluate all possible schedule changes. Hence, they may miss some profitable schedule changes.
- Running schedule evaluation tools on an overbuilt schedule leads to erroneous demand estimates. The errors increase with the amount overbuilding. Consequently, only small incremental changes can be evaluated with reasonable accuracy.
- The problem size that can be solved by *Fleet Manager* in drop mode efficiently is limited. Heavily overbuilt schedules cannot be solved.
- Several iterations between the schedule evaluation tool and fleet assignment models are necessary to arrive at the final schedule.

We conceived and are developing the *Sabre® AirFlite™ Network Manager* to automate the schedule design process and overcome current procedural limitations. *Network Manager* will consist of two functional components: the structure optimizer and the timing optimizer. The structure optimizer will determine fleet size, service frequencies and bank composition that maximize schedule profitability. The timing optimizer will determine flight times that maximize profit. The structure and the timing can be used independently for long-term schedule structure planning and large-scale re-timing, respectively. When used together, the two optimizers will produce a fully timed schedule with a new schedule structure.

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> "*Network Manager* can be used in a variety of scenarios from large-scale schedule re-timing exercises, service frequency optimization and bank restructuring to hub redesign and even clean-sheet scheduling."

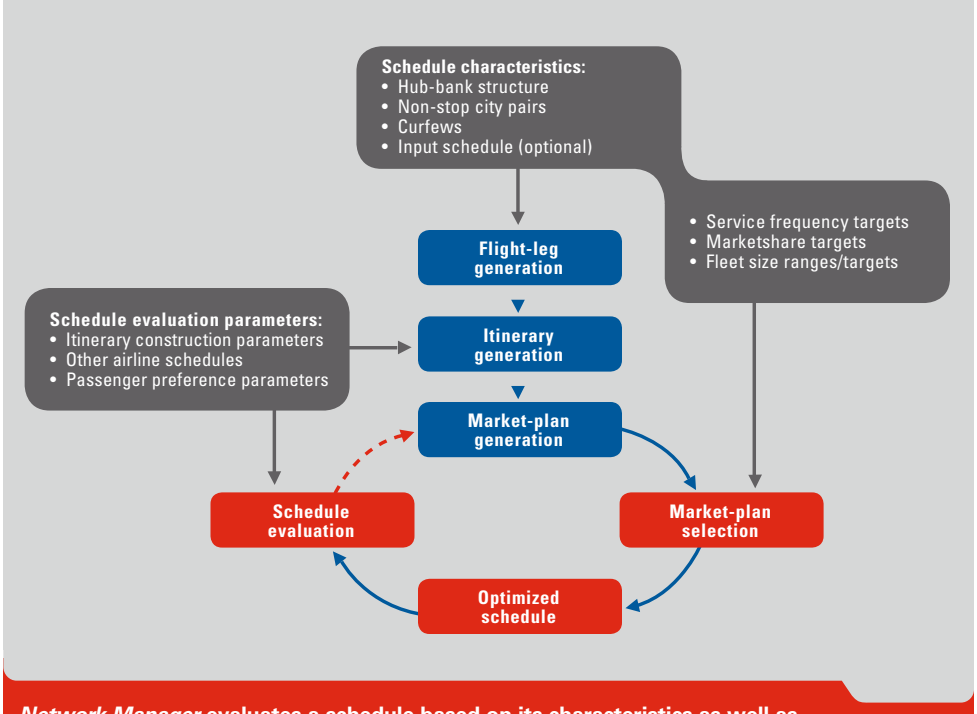
ule re-timing exercises, service frequency optimization and bank restructuring to hub redesign and even clean-sheet scheduling. In this context, *Network Manager* can also determine optimal fleet sizes. Alternately, *Network Manager* can be used to evaluate codesharing agreements between airlines to determine viable and desirable routes across the combined airline networks.

## Structure Optimizer

The structure optimizer takes two types of inputs: one to determine schedule options and the other that determines schedule profitability. Scheduling options are defined by the hub/bank structure, desired fleet sizes, potential services, curfews, service frequency and market share constraints. Schedule profitability is computed using other airline schedules, passenger preference parameters and itinerary construction parameters. The inputs are processed in four phases: leg generation, itinerary generation, market-plan generation and market-plan selection. The first phase is executed only once at the beginning of the process, the other two phases are executed iteratively until a final schedule has been found.

The leg-generation phase produces the set of all possible flight legs that can be considered during schedule development. Alternately, all feasible flight legs can be provided as an input to the solution process. Once leg generation is completed, *Network Manager* generates, for each market, all possible passenger itineraries. In this context, *Network Manager* uses the connection building parameters and other airline schedules provided by the user. *Network Manager* can also read as input a set of itineraries generated by a third-party tool. This is useful if itinerary generation and pruning involves rules that are not captured by the internal itinerary generator within *Network Manager*.

### Network Manager Work Flow




***Network Manager*** **evaluates a schedule based on its characteristics as well as certain parameters. The schedule inputs are processed in phases that lead to a final optimized schedule.**

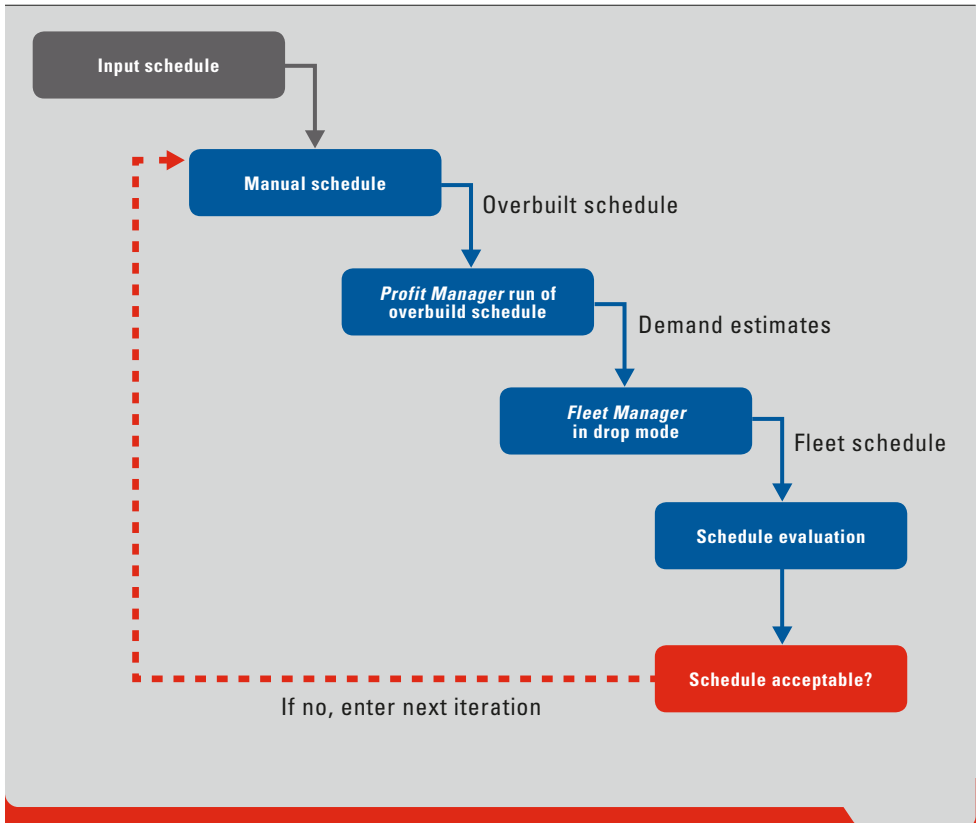
The itinerary set forms the basis of market plans, which define the airline's service pattern for a given market and the associated demand, market share and revenue. *Network Manager* generates several market plans for each market. The final schedule is constructed by selecting one market plan for each market. Plan selection is driven by overall schedule profitability and restricted by plane count, service frequency, and market share targets and constraints.

Market-plan generation and market-plan selection are executed iteratively until no further improvement is observed in two consecutive iterations. A new schedule is obtained at the end of each iteration. If the initial schedule satisfies all constraints, then all following schedules also satisfy the constraints. Otherwise, the first iterations are used to arrive at a schedule that satisfies all constraints.

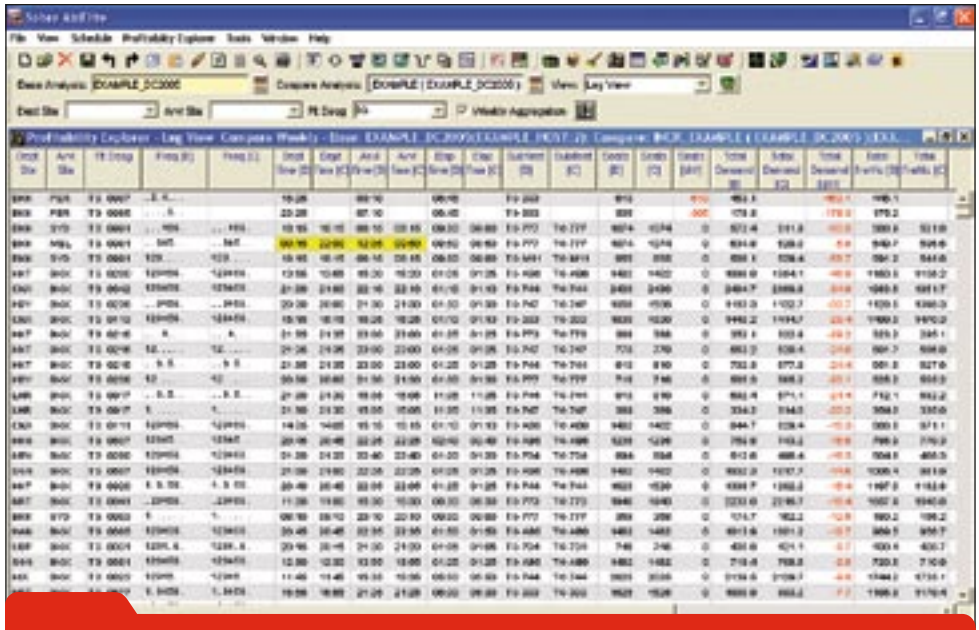
## Timing Optimizer

Benchmark studies have shown the structure optimizer is well suited to optimize the structure of the schedule. However, it is not

## Schedule Design Process




**Designing an optimum schedule is an iterative process that involves several steps that incorporate an evaluation of a potential schedule and its profitability.**



***Network Manager* utilizes "incremental mode" functionality similar to *Profit Manager*. Such functionality enables schedulers to analyze incremental changes to a schedule to determine the most beneficial adjustment, for example, whether eliminating a Bangkok-Perth flight to add another flight makes financial sense. While *Profit Manager* focuses on comparing one set of changes, as seen here in its Profitability Explorer module, *Network Manager* generates and evaluates multiple sets of changes.**

very efficient when it comes to flight re-timing. In particular, the small difference in flight timing yields a large number of scheduling options for each market plan. The timing optimizer was designed to solve the re-timing problem more efficiently. It executes the same solution phases as the structure optimizer: leg generation, itinerary generation market-plan generation, and market-plan selection. However, it is based on a different market-plan definition.

Leg generation requires the current schedule and re-timing windows. A set of re-timing points is generated for each re-timing window and flight copies are generated for each of the points. The copies, together with the original flights, form the set of potential flights for the final schedule. Alternatively, the analyst can provide *Network Manager* with the set of potential flight legs directly. The itinerary generation process is the same as the one described for the structure optimizer. As with the structure optimizer, the user has the option to provide the set of all itineraries directly as input.

During market-plan generation, the timing optimizer treats all itineraries that represent the same sequence of original flights as one itinerary. Hence, one market plan corresponds to many service patterns, and service-pattern selection is moved to the plan-selection stage. The plan-generation and plan-selection phases are executed iteratively until no improvement is observed over two consecutive iterations.

A working prototype of the timing optimizer is still being built. However, first results on a weekly schedule with about 1,900 flight legs indicate an upside of up to 3 percent of base revenue. Moreover, the problem can be solved within two hours.

## Benchmark Studies

The structure optimizer has been benchmarked on a variety of schedules and scenarios. The first benchmarks were done on a weekly base schedule containing 1,800 flight legs. The carrier was operating one major and one secondary hub.

The objective of the first study was to change service frequencies and timing to maximize expected profit. Fleet size and bank-hub structures remained unchanged. The structure optimizer was able to increase profit by 1.8 percent of base revenue.

Our second study focused on building out the secondary hub to a major hub and establishing a new secondary hub. In this study, the fleet size remained fixed, but the hub-bank structures of all three hub stations were altered. The resulting schedule showed a profit of 5.3 percent above that of the base schedule.

Another benchmark was performed on a 900-flight daily schedule. This study was done in cooperation with the consulting practice

at the *Sabre Airline Solutions*® business. The objective was to redesign the bank structure of one of the two hubs. This was the first study in which fleet size was also variable. *Network Manager* produced a schedule that improved profitability by 10 percent of base revenue. Moreover, *Network Manager* made recommendations regarding the carrier's fleet composition. The carrier acted on the recommendations and increased its number of regional jets substantially.

In another benchmark study, *Network Manager* was used to modify the structure of only one hub while keeping flights not touching the hub unchanged. The objective was to reduce the hub's activity by 30 percent. *Network Manager* output was compared to a schedule produced by schedule planners using the traditional approach. The system's output schedule met all the requirements and matched the planner's schedule in profitability with minor differences in service frequencies.

The latest benchmark was concerned with clean-sheet scheduling. In this scenario, *Network Manager* started only with bank-hub structure, fleet-size restrictions, a list of non-stop city pairs and service frequency restrictions that reflected strategic objectives and operational constraints. *Network Manager* was again able to produce a schedule of the same quality as a schedule produced in several weeks of planning using the traditional approach.


Photo by Colin Work/AirTeamImages.com

**A benchmark study of *Network Manager* indicated the tool can re-time a schedule to maximize passenger flows across the network, helping reduce passenger delays.**

All *Network Manager* benchmarks performed to date have shown that the tool can produce high-quality schedules. In addition, benchmarks proved that system can be used not only to restructure and re-time a schedule but also to do clean-sheet scheduling as well as fleet planning. Equally important, *Network Manager* enables planners to reduce time from several weeks to a few days. Therefore, we believe that the tool has a lot of potential in the market place in a variety of schedule optimization and planning scenarios.

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## Optimizing Schedule Changes

| Description | Schedule Characteristics | Profit Increase | Run Time |
|---|---|---|---|
| Optimize service frequency for fixed-bank structure and fleet size | • Weekly<br>• 1,800 legs<br>• 1 major hub and 1 secondary hub | 1.8% | 2 hours |
| Establish one additional major and a secondary hub with fixed fleet size | • Weekly<br>• 1,800 legs<br>• 1 major hub and 1 secondary hub | 5.3% | 5 hours |
| Optimize bank structure of one of two hubs and fleet size | • Daily<br>• 900 legs<br>• 2 hubs | 10% | 11 hours |
| Reduce fleet size activity at one of three hubs with remaining schedule fixed | • Daily<br>• 5,000 (1,000 variable) legs<br>• 3 hubs | 1.5% | 6 hours |
| Clean-sheet scheduling with variable fleet-size and service-frequency targets | • Weekly<br>• 1,500 legs<br>• 1 major hub and 1 secondary hub | No base | 10 hours |

**By using new automation tools, airlines can quickly conduct large-scale rescheduling exercises that result in a more profitable schedule.**