Solution Concept for REDDIG II Based on SkyWAN Technology
Presented by ND SatCom at the ICAO/SAM Workshop, Lima 18-20 July 2011

Dr. Wünderlich // 19.07.2011
Solution Concept for REDDIG II

Agenda

- ND SatCom Involvement in VSAT for ATC
- Can the expectations for REDDIG II be met
- Design Elements of a VSAT Network - Methodology
- Practical suggestions
Air Traffic Control Networks

ND SatCom provides satellite based aeronautical communications solutions since 1999 to
- National air traffic management agencies and
- supranational associations

in cooperation with the respective organizations and
- Prime Contractors of turnkey projects
- System Integrators and Service Providers

South Pacific  Central Asia  Africa  China
Communication links for Air Traffic Control
SkyWAN Solutions meet the requirements

- **Key Features**
  - Digital multi service communication platform supporting
    - *Real-time service for Radar data*
    - *highest Quality-of-Service for voice applications (PAMA and DAMA)*
    - *Aeronautical message transfer service TCP/IP based*
    - *administrative phone/fax/data services*
  - enhanced with ATC-specific access devices for:
    - *legacy interfaces*
    - *remote VHF communication controller-to-pilot*
  - *High network reliability, based on customized redundancy concepts*
  - *High available Network Management System, SNMP based*
  - *Capable for fully meshed network topologies*
  - *Bandwidth efficient with lowest operational costs*
### Aeronautical VSAT Networks with SkyWAN

<table>
<thead>
<tr>
<th>Prime Contractor</th>
<th>Country</th>
<th>Customer / User Organisation</th>
<th>Stations</th>
<th>Primary Applications</th>
<th>Year</th>
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<tbody>
<tr>
<td>IATA, Afghanistan</td>
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<td>various applications (encrypted)</td>
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</tbody>
</table>
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Can the Expectations for REDDIG II be met

- One decade later in the SatCom Industry
- Improvements in cost effectiveness
- Improvements in system performance
- System adaptable to new requirements
- Long term hardware support

All the space you need
Can the Expectations for REDDIG II be met

Modem related Improvements in cost effectiveness

- Superior TDMA Architecture
  - time slot size can be customized for the applications
  - every time slot can contain information to all nodes listening to the carrier
  - Carrier sizes can be adjusted to traffic requirements & optimized for ODUs

- 8PSK Modulation and Turbo Phi Coding

- Reduced Channel Spacing
Improvements in system performance

MF-TDMA Frame Layout – up to 8 Frequency Channels
Improvements in system performance

MF-TDMA Frame Layout – Streaming Slots – Jitter Free
Improvements in system performance

- Internal Control Traffic (e.g. OSPF, ARP)
- Management Traffic (SNMP)
- IP Forwarding Behaviors
  - Platinum
  - Platinum Dynamic
  - Titanium
  - Gold TCP-A
  - Gold
  - Silver
  - Bronze
  - Default
  - Drop

- Transmit queues per channel per IDU
  - FR Real Time
  - IP Real Time 1
  - FR Control - NSM
  - IP Control 1
  - IP Real Time 2
  - IP Control 2
  - FR Non Real Time
  - IP Non Real Time

- Requires Stream Slots
- Requires Dynamic Slots

- RT Traffic handle with highest priority - jitter-free
- High Priority for management traffic and guaranteed network operation
- Several NRT traffic classes

All the space you need
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Design Elements of a VSAT Network Solution for REDDIG II?

<table>
<thead>
<tr>
<th>Information input:</th>
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<tbody>
<tr>
<td>Traffic (quantity, quality, connectivity)</td>
</tr>
</tbody>
</table>

All the space you need
Designing & Costing a VSAT Network is an iterative process.
Design Elements of a VSAT Network

Iterative Designing Process VSAT Network:

- Aggregate traffic flow in the network to a total required data rate capacity
differentiate between PAMA and DAMA traffic

- Estimate volume of required satellite capacity and secure budget for it

- Find suitable satellite with available capacity and make a reservation

- Run link budgets with variations of antenna size, modulation and FEC rates for
locations with significant pattern (dis-)advantages in the footprint

- compare cost of ownership over the assumed life cycle for different scenarios of antenna
sizes, RF power and bandwidth consumption
Design Elements of a VSAT Network

Iterative Designing Process VSAT Network cont’d:

- Select antenna sizes and maximum carrier data rates (for min. RF power)
- MF TDMA carrier design according to
  - traffic volume’
  - connectivity and
  - efficiency
- total minimum bandwidth requirement (to be contracted)
- System design, network layer diagrams
- Station design, equipment configuration diagrams
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Practical suggestions

All IP based network ???

- Ground air communications
- Dangerous applications
- Congestion avoidance (by design)

→ Go ahead !!!

Impact of IP based connections

- Capacity and bandwidth planning: IP Voice communication is no longer planned according to number of voice channels, but according to Bandwidth and latency requirements
- QoS and priority handling: Mixing safety critical and administrative communication must be planned carefully as the network itself does not guarantee latency and packet-loss (especially in congestion scenarios)
Practical suggestions

Migration from REDDIG I:

Big Bang
REDDIG II will be implemented parallel to the still operational REDDIG I. Once complete and fully tested REDDIG I is switched off and all peripheral devices are connected to REDDIG II, which starts operation immediately thereafter.

Drawback: service interruption

Step by Step
The core of REDDIG II will be implemented and one node after the other is switched over from the still operational REDDIG I to the new network.

Drawback: complicated procedure; temporarily reduced connectivity (double hop)

In any case:
extra satellite capacity required in the transition period
a second antenna is advantageous (regardless whether the satellite remains)
Practical suggestions

Network Availability for REDDIG II

Where is the pain?

- Link availability variation 99.5% → 99.99% requires ~50% more power
- How to count for the other factors? Per link / per total network (which metric?); per year / per worst month?
- What to assume for the MTTR?
- Terminal design must reflect differences in MTBF for components

MTTR: Mean Time To Repair
MTBF: Mean Time between Failure
Practical suggestions

VSAT Network Problems

The causes for failures (by importance):

- Poor installation
- Power outage
- Lightning
- Satellite Interference/Outages
- Interference from terrestrial and airborne sources
Redundant Chain
FR/ using FAD/ Layer 2 Switching

SkyWAN IDU
SkyWAN FAD
Switch
SkyWAN RFT
Redundant Chain

IP/ no external Device/ Layer 3 Routing

SkyWAN IDU
Router
SkyWAN RFT
Practical suggestions

Enhanced Support Option out of Europe for System Integrator/Manufacturer

Satellite Capacity
e.g. on NSS-806/SES-6
Thank you for your attention!