27th Satellite Network Management Committee
Accra Ghana, 25 – 29 November 2019

ND SAT COM

A NEW DIMENSION IN SATELLITE COMMUNICATION

ND SATCOM – At a Glance

Company

Ground segment SatCom System Integrator, manufacturing key components

Over 30 years Experience

140 Employees based at Lake Constance (Germany), Dubai, Beijing and Dakar

Our Strengths

No 1 in Air Traffic Control

No 1 in SNGs for European Broadcasters (400 SNG uplinks wordwide)

Over 200 earths stations delivered (3,8-16m)

100s of networks world wide

More than 10.000 SKYWAN terminals l**eading position** in meshed networks

Turnkey supplier of Satcom Ground Segment to Armed Forces

SOTM solutions for military and commercial networks

Evolution of Communication Technology based on SKYWAN satellite router technology

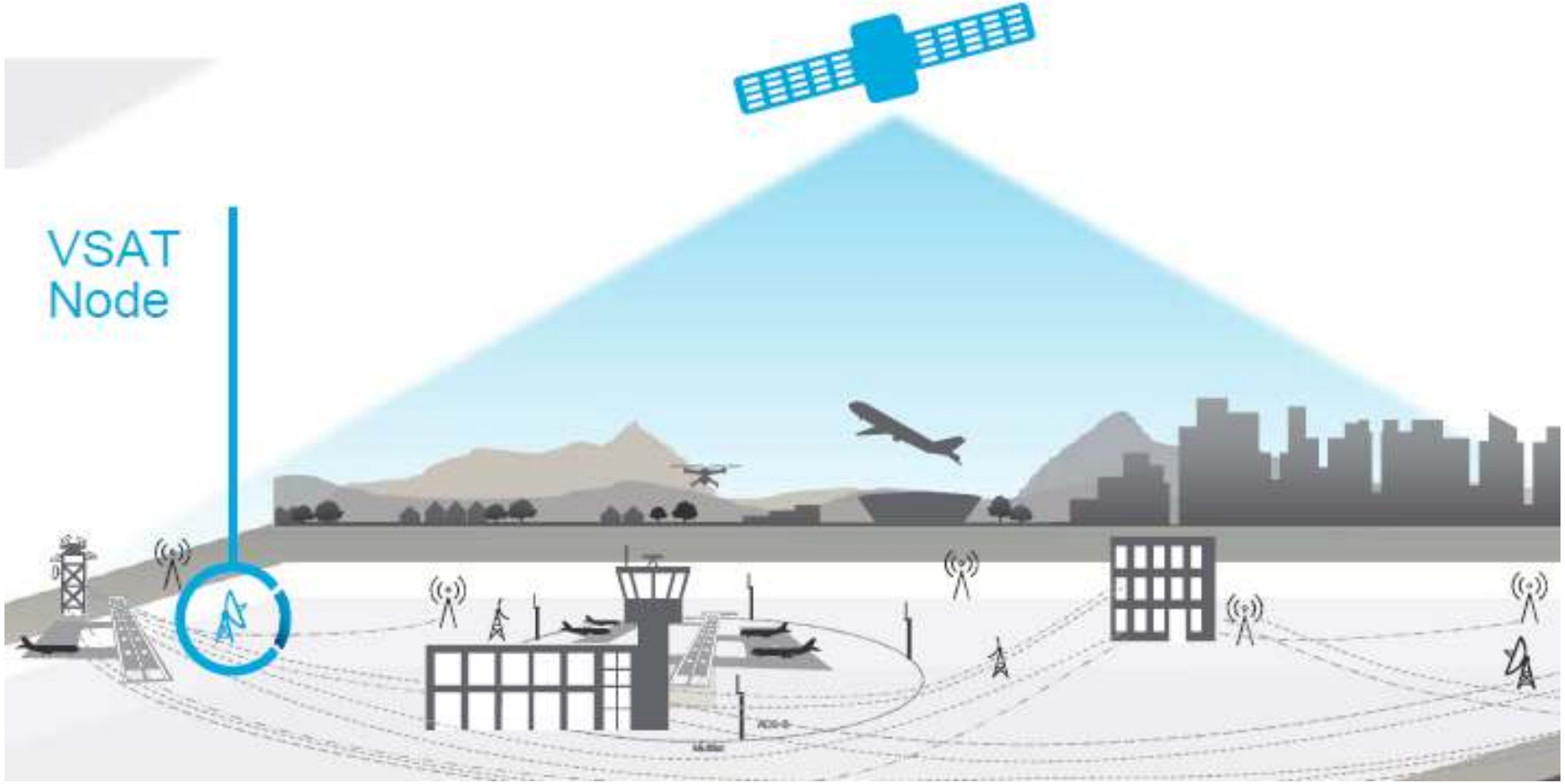
Guenther Eisele

Senior Manager Operations
Governmental VSAT Networks

ND SatCom - Germany

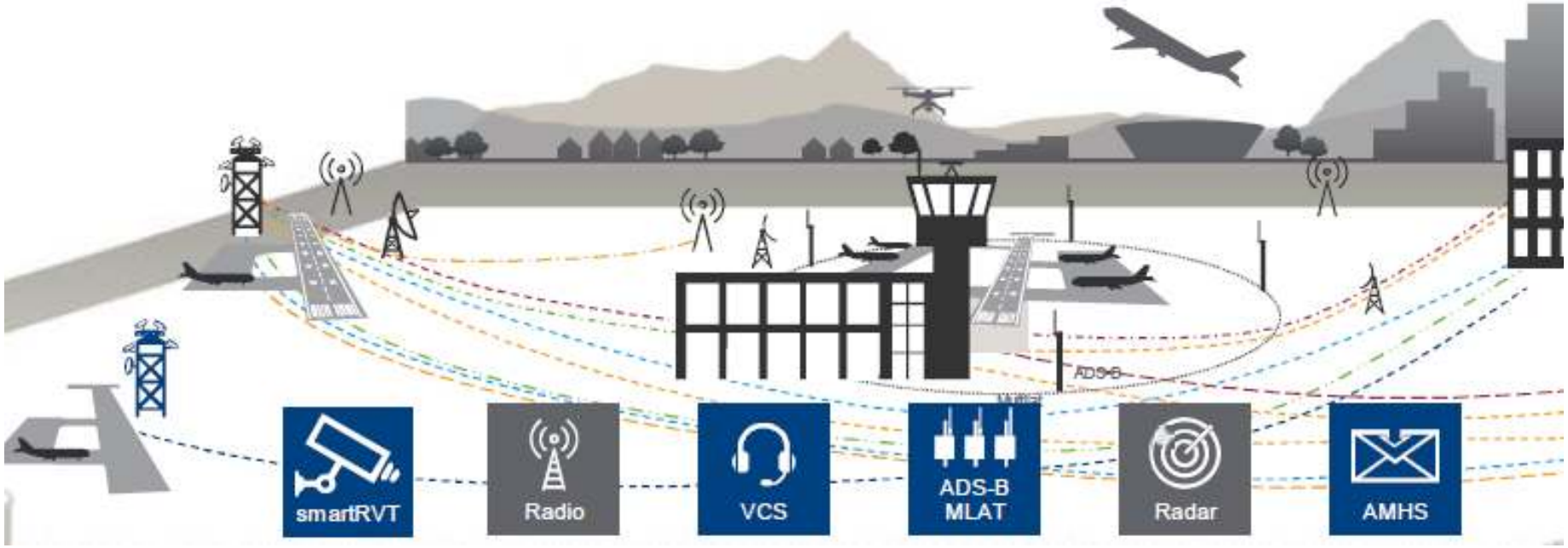
Satellite communication networks for ATM / ATC

The VSAT communication network provides wide area network (WAN) connectivity for the ATM / ATC facilities and their applications.



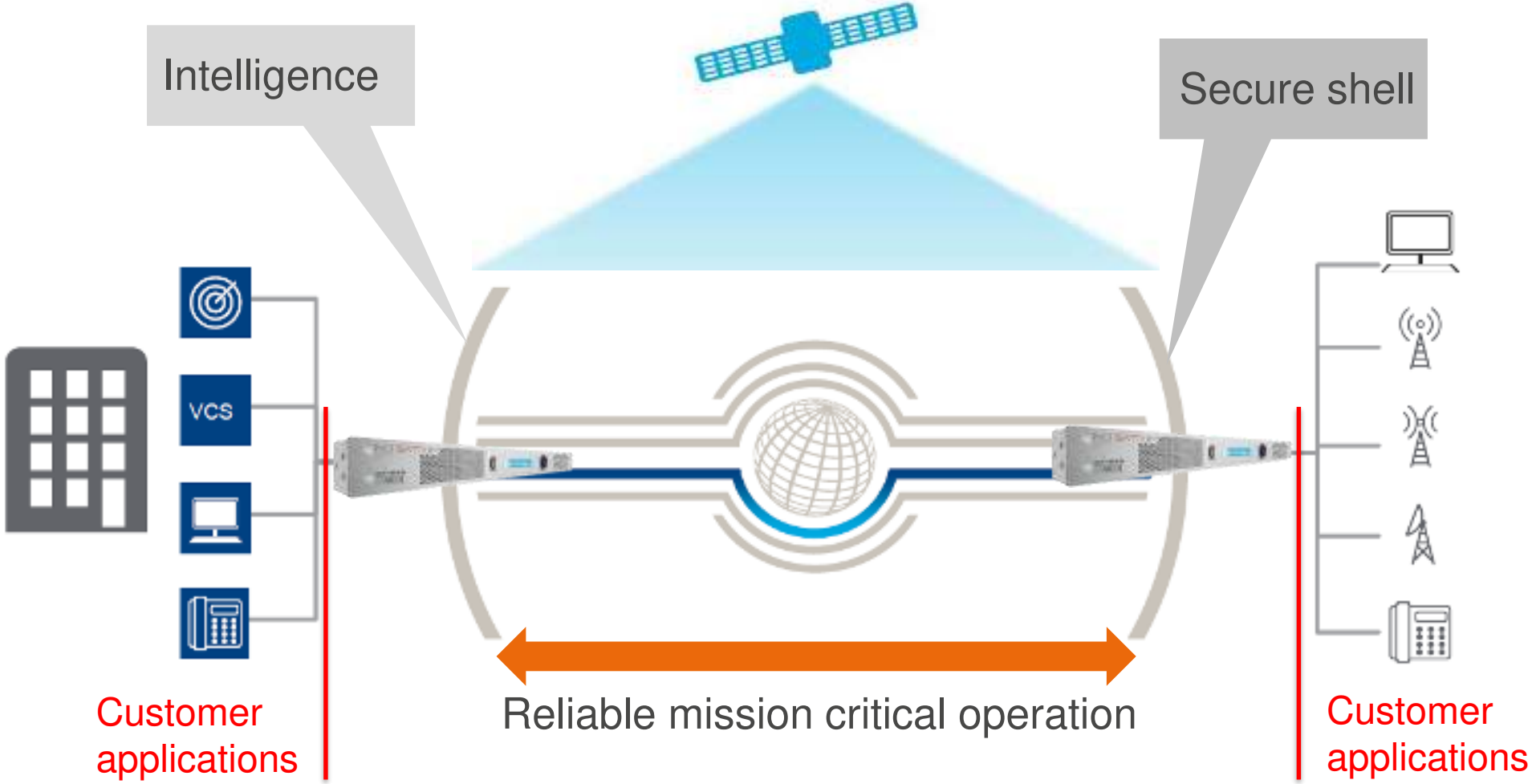
Satellite communication networks for ATM / ATC

Complex ATM / ATC environment with various national / international spread facilities and different applications / sub-systems.



Satellite communication networks for ATM / ATC

SKYWAN technology provides an intelligent and reliable communication shell over satellite WAN – securing operational links of the customer applications.



Overview – Sub-systems of VSAT Network for ATM / ATC

Customer

System VSAT Network

Baseband system (Applications)

Modem Sub-system

VSAT NMS Sub-system

Multiplexer / Switch Sub-system (optional)

Indoor

HF Sub-system

Antenna Sub-system

Outdoor / ODU

Space segment WAN (Satellite capacity)

Expectations from “ATM grade” VSAT networks

Redundancy & Availability
(at station and network level)

Path diversity (with terrestrial
and / or satellite links)

Intelligent, flexible
routing & control

Scalable networks to secure future
operational needs

Network security (i.e. prevent unauthorized access)

Optimized bandwidth usage
(to minimize operational cost)

Integration of diverse
technologies and multiple vendors

Protecting legacy investments (e.g. step-wise migration to an “all IP environment”)

Enable future concepts (i.e. dynamic sectorizing, virtual centers)

SKYWAN modem technology platform

- **Field-proven** MF-TDMA technology in service since 1998; operational for ATM/ATC in > 65 countries,
- **Fully mesh network connectivity** within one modem hardware (no limitations for on-the-fly adaptations to changing network links and varying traffic patterns),
- **Lowest call setup times**,
- Multi-service platform for manifold protocols and baseband interfaces,
- **High reliability for network operation** and link continuity (i.e. seamless automatic network-master switch, local modem redundancy, adaptive coding),
- **Automatic bandwidth assignment on demand**,
- **Unique traffic prioritization mechanism** (QoS) suited for radar data transmission and VHF radio voice calls,
- Outstanding modem performance (high data rates, bandwidth efficiency, voice quality),
- **Secure network communication** (i.e. different security layers and independency of shared Hubs)

Modem technology platform - hardware

Software update
via USB-port

2-row display for
information & setup

Button for manual
navigation & selection

Symbol rate: up to **12 Msps**
User data rate: up to **20 Mbps**
duplex for Transmit and Receive

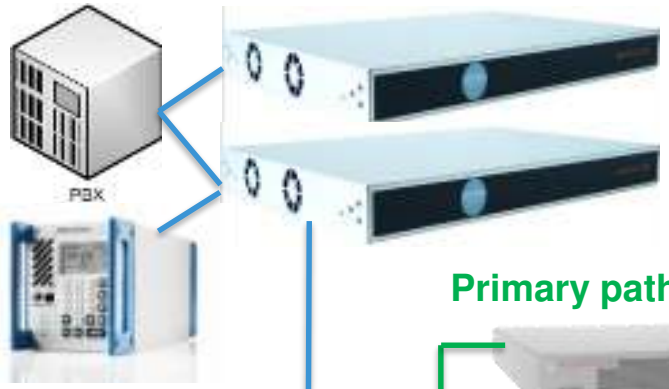
Traffic switching rate: > 65,000 pps

Modem technology platform

SKYWAN 5G series Easy local management access

Different user roles with different access rights

Station layouts: IDU and ODU in full redundancy configuration



Radio VHF voice

AMHS (IP data)

Local IP LAN (Baseband)

ADS-B (IP data)

Primary path

Usage of built-in IP router and redundancy protocol

Secondary path:
- in case of failure
- **optional for increased traffic / load-balancing**

HF-subsystem

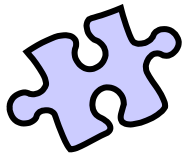
- no waveguide switches
- simple, robust design

- in case of antenna failure
- option for easy satellite migration

?

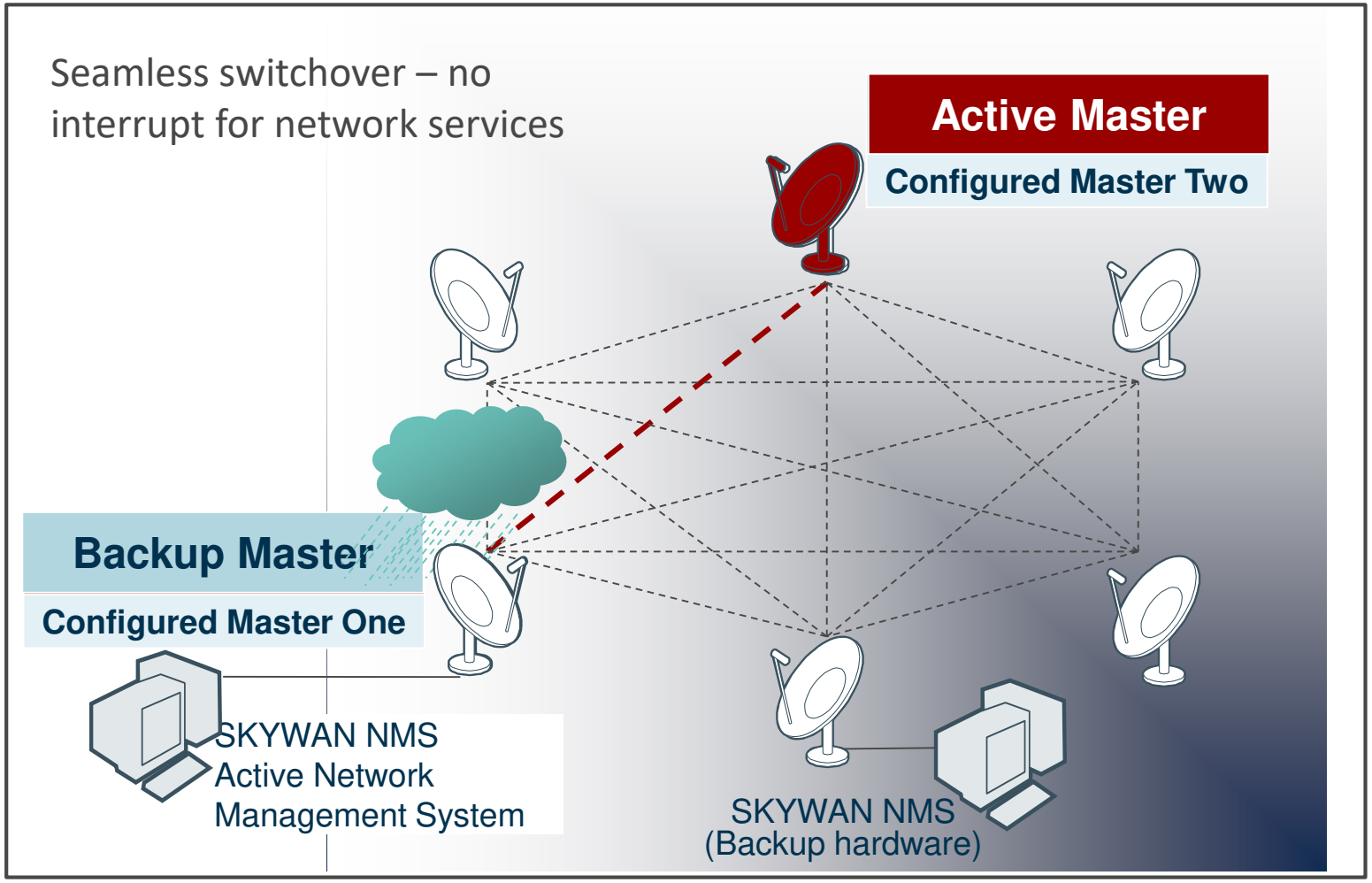
- Redundancy & Availability
- Flexible network topology and station connectivity
- Modem performance features

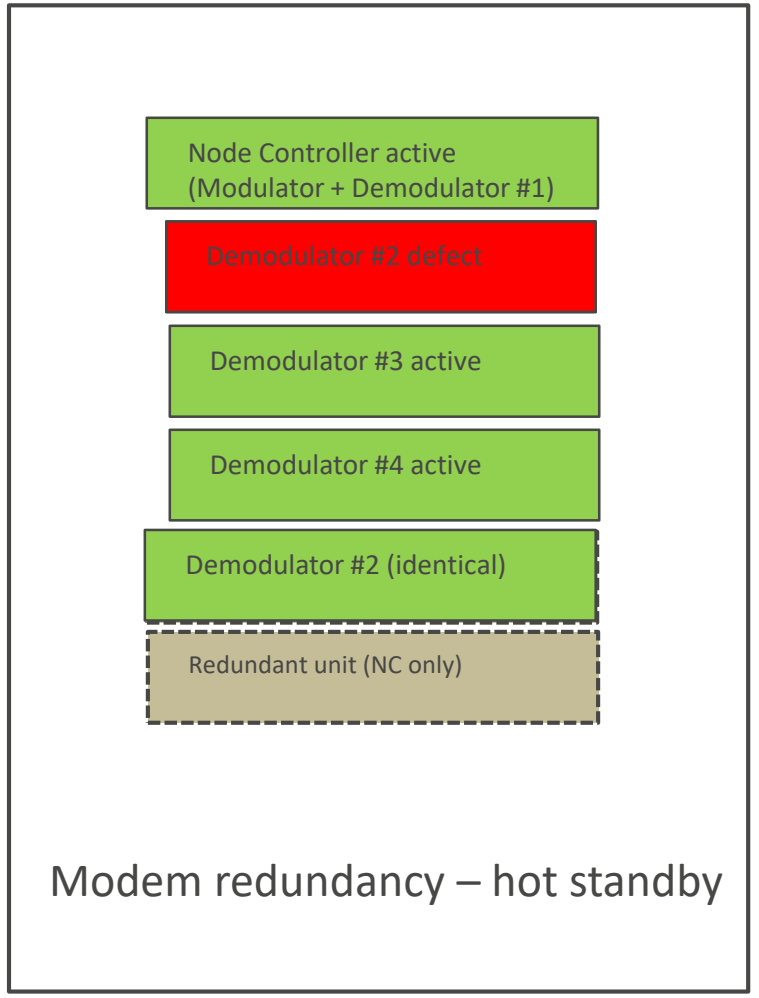
Redundancy & Availability (at station and network level)



- **Seamless** Master/Backup-Master switchover (at network level)
  - secure ongoing network operation – **no service interruption** (between not affected stations)
  - allows for **geographical redundancy**
  - **multiple network masters** – new backup-master will be “ongoing” selected according station status & defined rules
- Modem redundancy (at station level)
  - auto-switchover with **1+1** or at stacked modems with **m+n** (by local redundancy management protocol)
  - redundant modem(s) in hot-standby (with no multi-carrier back-off for the HF subsystem)
- Fail-safe NMS function (at network level)
  - NMS server is not operation critical – only for monitoring and configuration changes
  - Traffic routing/shaping/QoS or satellite bandwidth access is built-in locally at modem
  - Multiple NMS servers with auto-synchronization configurable at any network station
- Mitigation mechanisms (e.g. rain fade, jamming) to secure mission critical traffic
  - **U**plink **P**ower **C**ontrol (**UPC**) built-in (at station level) – i.e. for the return-link
  - **A**lternate **C**hannel **S**election (**ACS**) – alternate routing between different, pre-defined receive channels
  - **A**daptive **C**arrier **M**odulation (**ACM**) – ongoing varying Modulation/Codec at slot-level within **TDMA**-frame

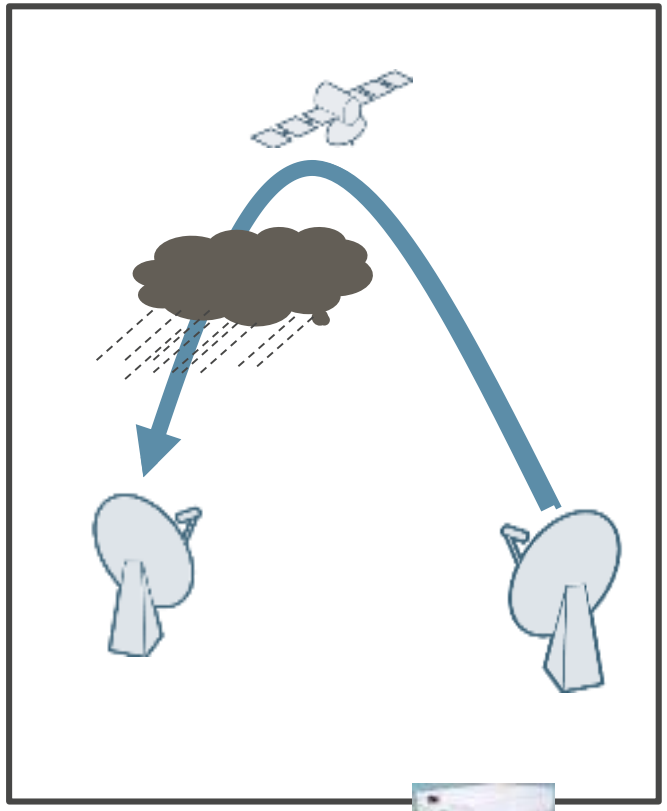
Redundancy & Availability

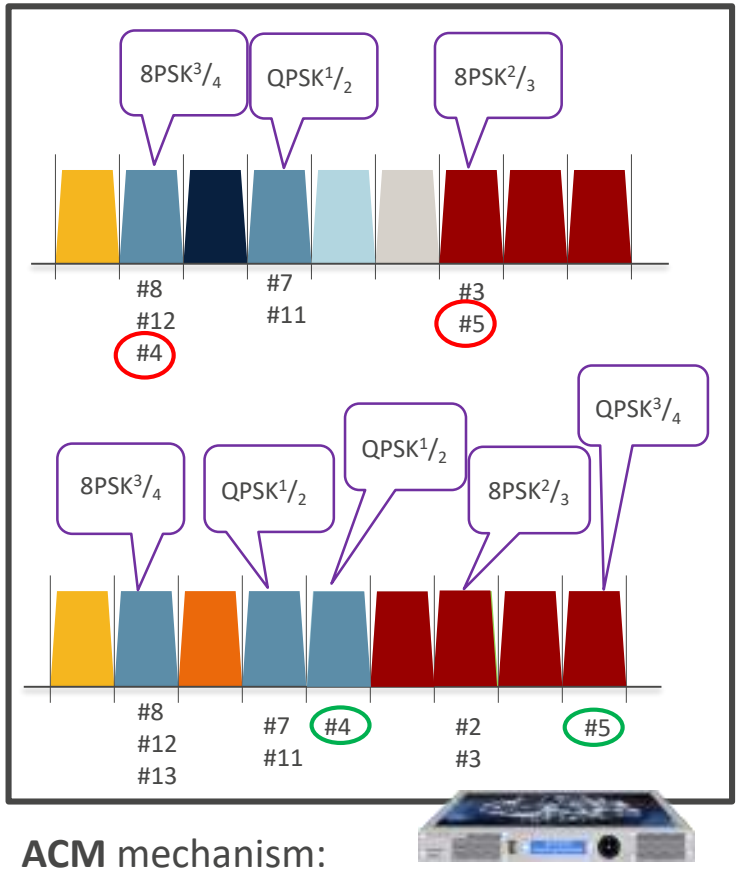


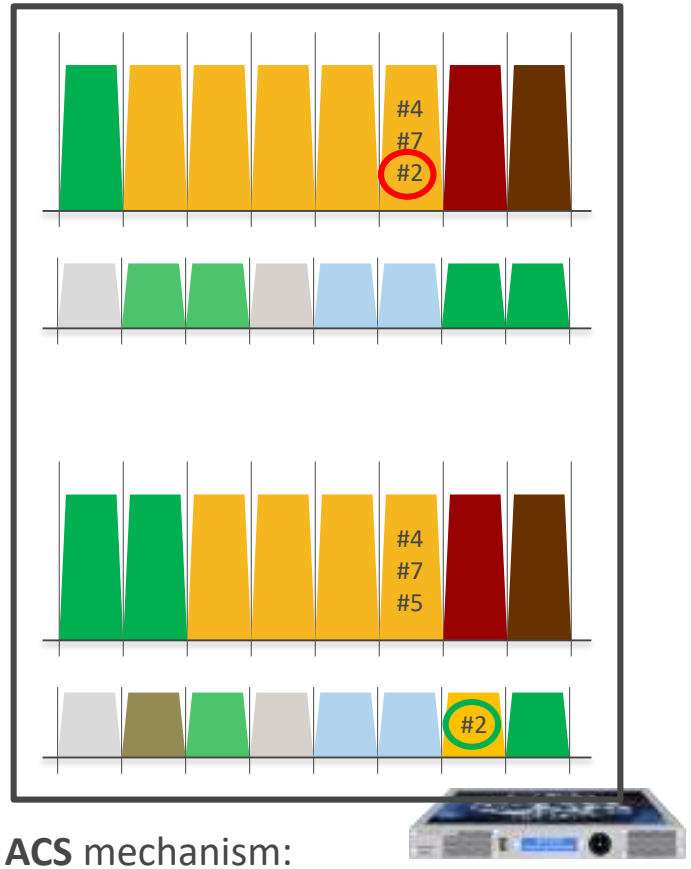


Network level - Station level

Redundancy & Availability – Link Continuity





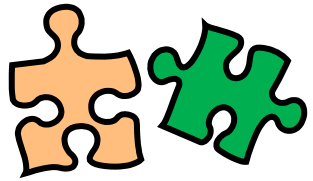


UPC mechanism:
amplifier power designed for worst case attenuation (adjustments continuously done by control cycle (~20%<< >>100%);
"Keep link alive with **stable data rate**"

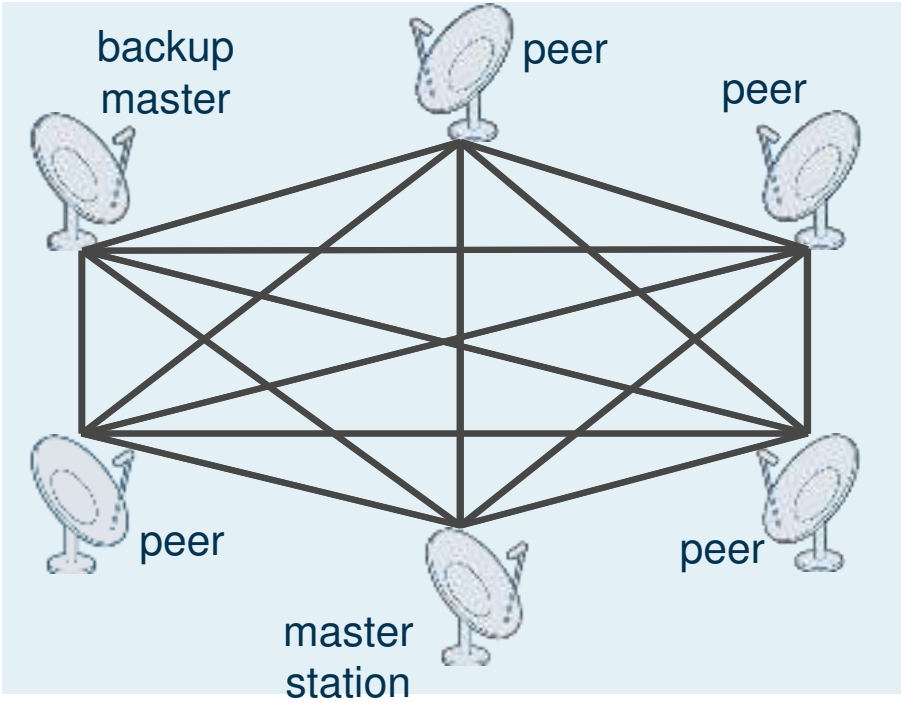
ACM mechanism:
At slot level of TDMA frame the modulation & coding will be continuously adapted to the attenuation scenario at the stations;
"Keep link alive, but with **lower data rate**"

ACS mechanism:
Alternate channel (out of bandwidth pool & 2nd demodulator) will be selected according the attenuation scenario at the stations;
"Alternate link, but with **stable data rate**"

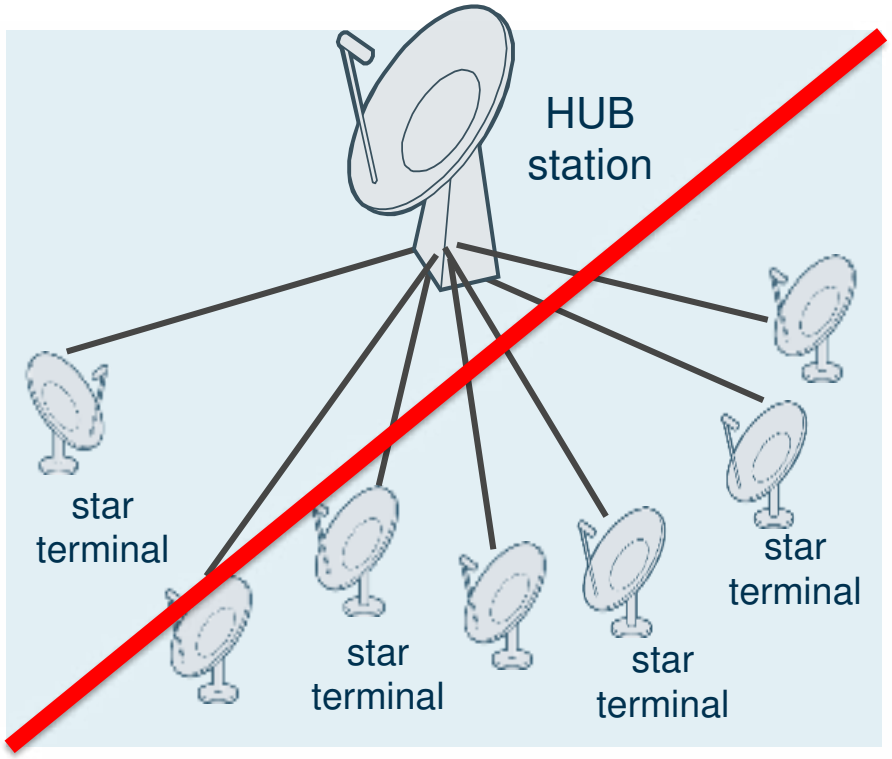
Flexible network topology and station connectivity by full-mesh MF-TDMA

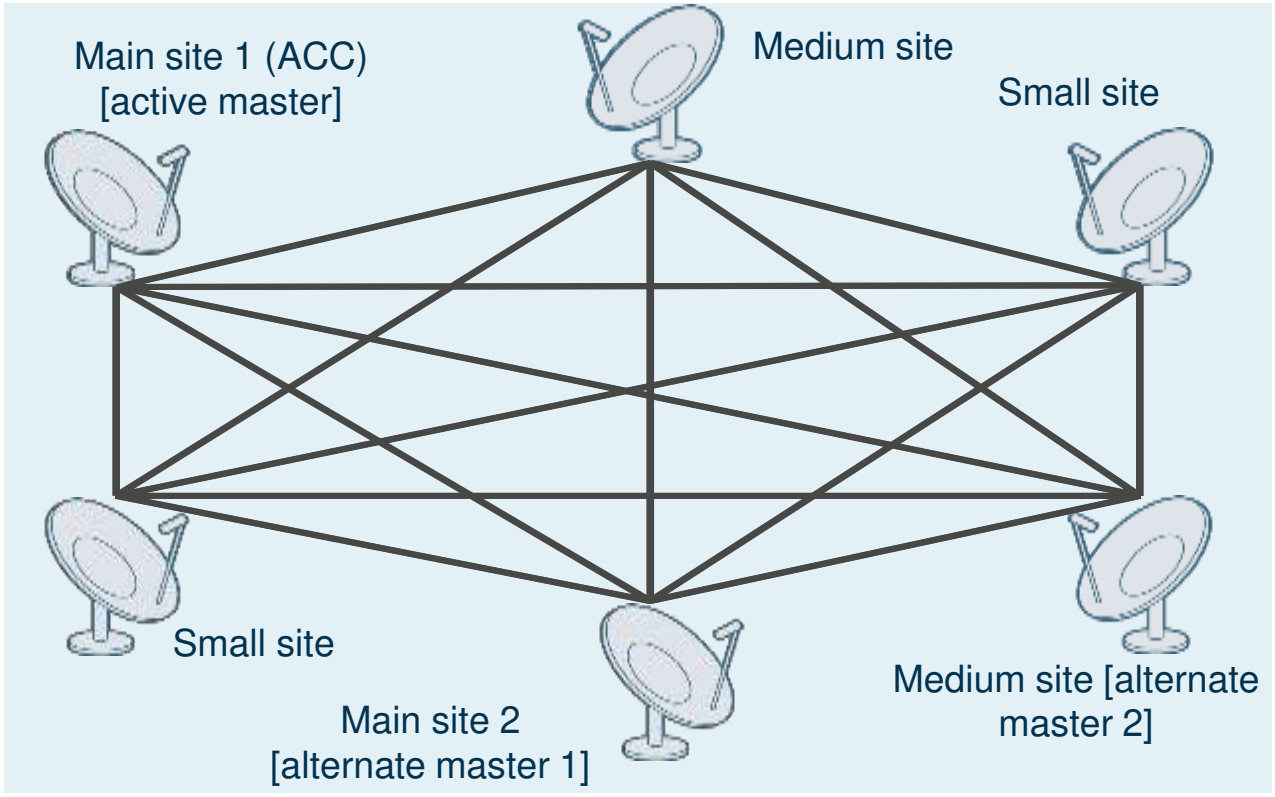


- Support of **changing network topologies** over the life-cycle with no limitations (i.e. star, multi-star, hybrid, hierarchical, mesh)
- On-the-fly adaptation to **varying traffic patterns** and links between stations
- Easy **scalable network size** (to secure future operational needs and current investments)
- One hardware model for all roles and features
- Provision of connectivity with **single-hop** transmission (guarantees for **lowest link setup time** and saves transmission bandwidth)
- Support of multicast transmissions in one modem
- Full NMS functionality / access is possible at any station
- Enable future concepts (i.e. dynamic sectorizing, virtual centers)
- Avoiding “shared HUBs” – secure, independent network



Flexible network and station connectivity by full-mesh MF-TDMA





Outstanding modem performance & prioritizing mechanisms

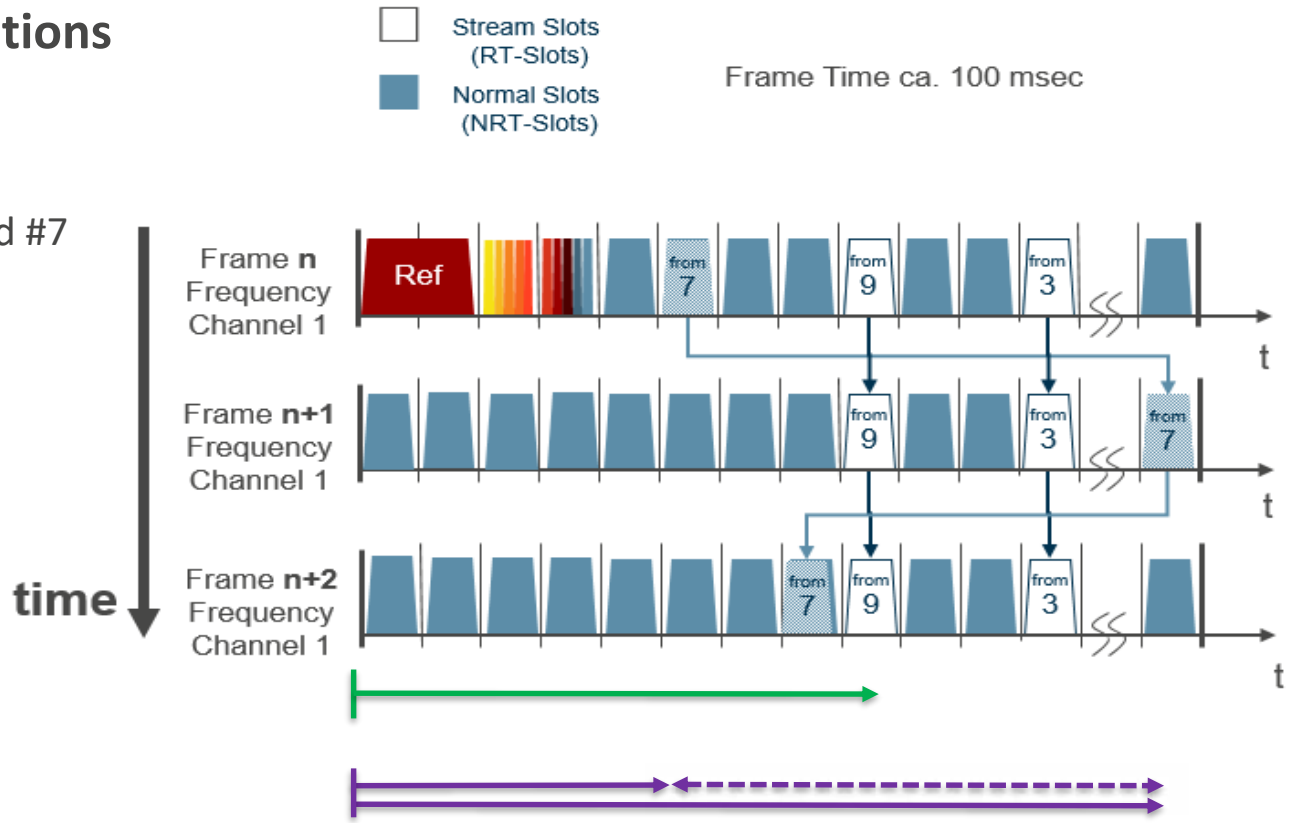
Lowest jitter – following ED137B regulations

Example:
Voice call (RT-traffic) between station #9 and #3
Non-real-time (NRT) traffic between station #9 and #7

Position of data packets
from TDMA-frame to TDMA-frame:

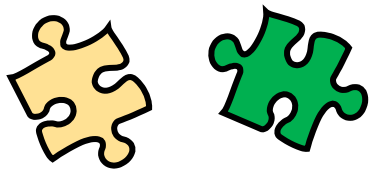
Queuing of RT-traffic packets is kept at the same slot position (variation within slot size)

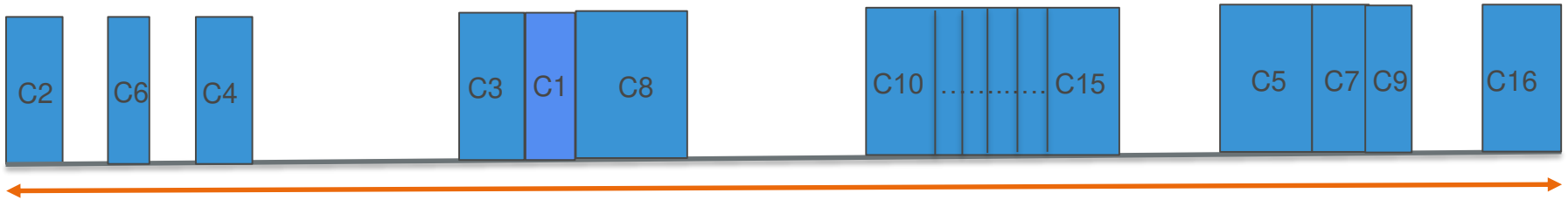
Queuing of NRT-traffic packets is flexible according utilization and priorities (variation over frame size)



- For ongoing real-time traffic (especially radar data and VHF voice calls) the bandwidth assignment is kept for the next frame (**constant delay with lowest jitter** – as even the slot position within the frame is kept for the next one –for this traffic class the **resulting variation is below 10 ms**).

Flexible network and station connectivity by full-mesh MF-TDMA

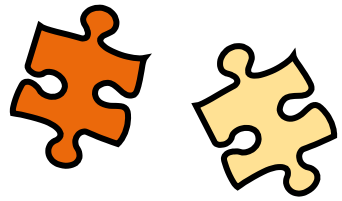




Usage of spotted, separated carrier portions

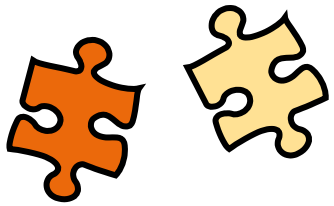
- No single bandwidth portion necessary for network capacity
- Easy network expansion year by year (e.g. gathering small left slots)
- Network operation more robust against jamming

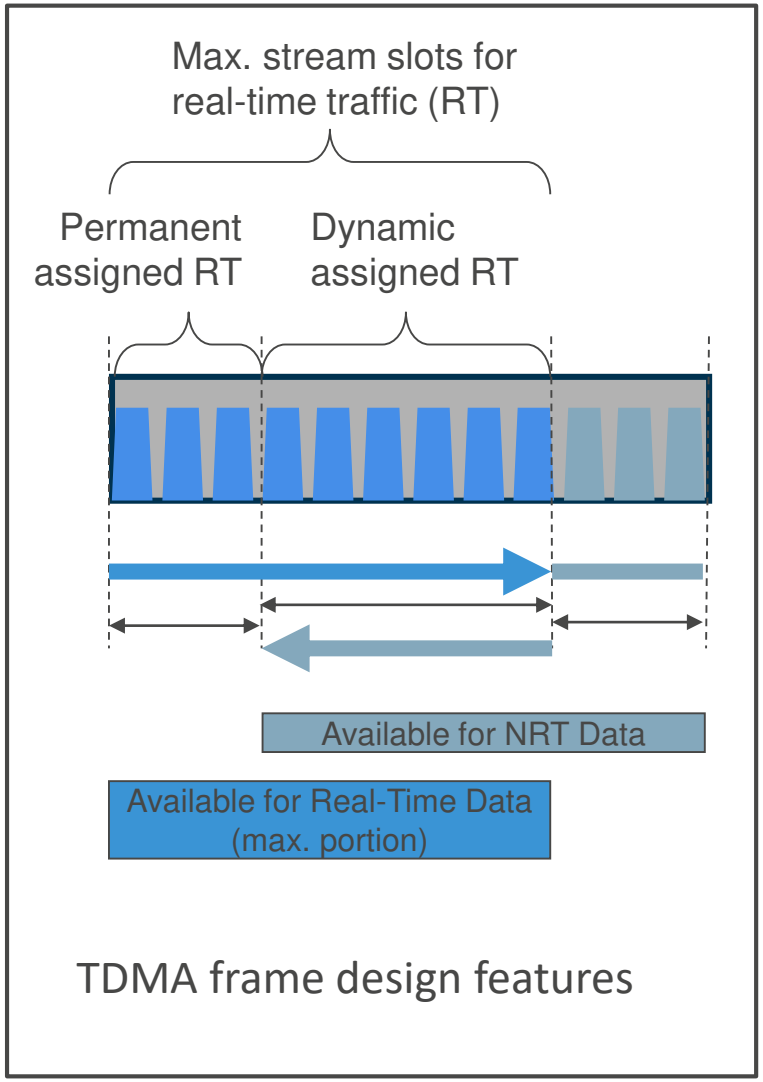
Outstanding modem performance & decentralization of intelligent functions



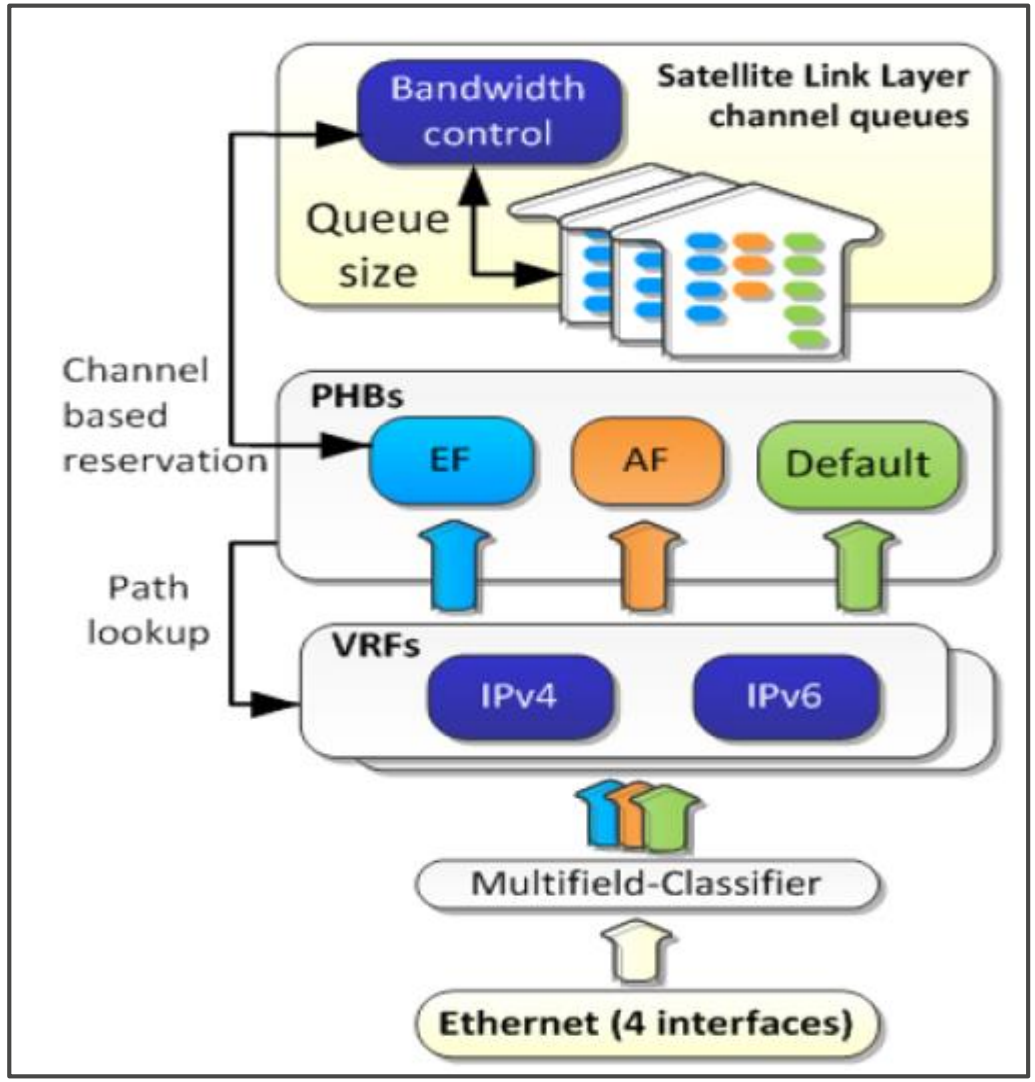
- Highest data rates (up to **20 Mbps** / **12 Msps** per carrier) – especially for meshed and return links
- Most efficient usage of satellite bandwidth to minimize operational cost
  - Low **channel spacing of 1.1 / 10%** for TDMA
  - Highest data slot fill rate (> 90%) – measured in real-environments
  - Auto load-balancing between carriers to optimize utilization between network carriers
  - Automatic bandwidth on demand (**BoD**) assignment (**every 100 msec**) per station and per carrier
  - Usage of spotted, separated carrier portions over the transponder (within a range of 1200 MHz) – simplifies future capacity increase and provides higher robustness against jamming
  - Support of multicast transmissions from any station
- Fastest multi-frequency hopping (over 16 channels within 10 microsec) resulting in lowest link latency
- Robust link continuity at any station/modem
  (e.g. local TPC adjustment combined with **outstanding Eb/No values** especially for the return link)
- Extreme dynamical behavior for traffic handling (i.e. suited for short call sequences)
- Comprehensive Quality of Service (QoS) functions to ensure mission critical traffic transmission
  (Prioritizing mechanism providing also “constant delay” with lowest jitter; flow-based QoS per station &channel)

Outstanding modem performance & prioritizing mechanisms





TDMA frame design features



IP protocol support:

- OSPF dynamic routing
- VLANs
- Different IP domains
- BGP
- DHCP
- DivServ
- GRE tunnels
- etc.


ND SATCOM
SKYWAN
5G

Our contribution

Value add

- Experience counts – when installing reliability
- Sustainable customized solutions over the entire life cycle

Portfolio

- Component delivery
  - own product house components (i.e. ***SKYWAN modem family***)
  - OEM products (e.g. ***SKYWAN FAD multiplexer family***)
  - tested 3rd party components / solutions
- Service delivery
  - Network design
  - Component pre-configuration / rack integration
  - **A**cceptance **T**esting (Factory AT / Site AT / Network AT)
  - Project management
  - Installation support
  - Training
  - Satellite capacity lease
  - Maintenance & operation support
  - Extended warranty & repair & service agreements

Further solution sets

Rack integration examples and Factory Acceptance Testing (FAT)

Further solution sets

Rack integration & complementing sub-systems / components

(i.e. online UPS, local NMS PC with rack-mount display & keyboard, router, patch-panels, OEM products / Multiplexers, customized NMS extensions, etc.)

Factory Acceptance Testing (FAT)

Examples

recent installations at remote radar site and at main station

SKYWAN 5G

The ONE
Enabling Agile Networks

Option: SKYWAN FAD models – additional baseband interfaces

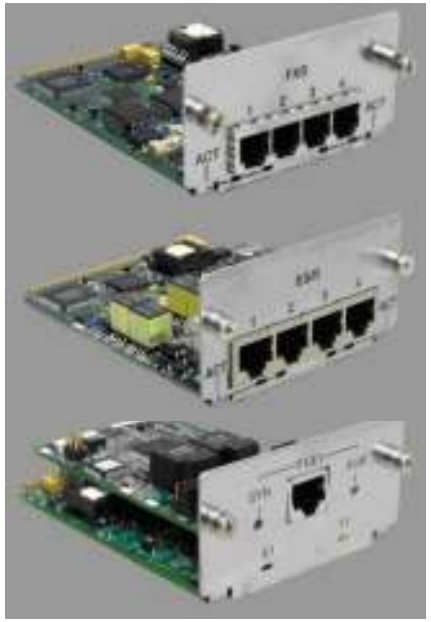
Note: FAD series is our OEM product since 1999 in several hardware generations

SKYWAN FAD provides the following interfaces:

- FXS 2w / FXO 2w
- E&M 4w
- E1 / T1
- Serial ports (RS-232, RS-449, V.35 etc.)

SKYWAN FAD supports the following features:

- Link Delay Compensation (LDC)
- Voice Compression algorithms
- Support of SIP G.729 (VoIP)
- Redundancy configurations



Cards: E&M 4w, FXS/FXO 2w, E1

Further site examples
(ATC / ATM)

Experience in networks for governmental organizations

- **Embassy network for MoFA Kingdom of Saudi-Arabia (with STC – KSA):**
  In total **119** VSAT stations (**2** main sites and **110** embassies); Roll-out started in April **2017**;
  Main stations in Riyadh and Jeddah each with 4 antennas; in total over 5 different satellites in C-band and Ku-band; Currently **98** embassy stations installed and accepted; roll-out closing January 2020; including space segment provisioning for 3 years and full maintenance for 3 years under contract; network with ND SatCom Transmission encryption (AES256) for fax, phone and data; just new contract for planned re-locations in 2020;
- **Emergency network for national organization in China (with LES – China):**
  In total more than **1350** VSAT stations operational; segmented in meshed provincial sub-networks with central crisis management; Roll-out started in early 2009 with core network; permanently ongoing network extension with ca. 110 new stations per year; hybrid network topology and configuration with 3 different SKYWAN modem generations operational in 2019;
- **Network for governmental organization in Kazakhstan (with local system integrator):**
  In total **29** VSAT stations (2 main, 15 fixed and 12 mobile stations); network ordered and finalized within 9 months by end of **2018**; extension with further stations currently under negotiation for 2020;
- **Network for Armed Forces in India (with GRINTEX/Bharat - India):**
  In total **62** VSAT stations; network with full automatic modem redundancy for all sites; network design and hardware delivery to local partner in early **2018** for further system integration;
- **Network for Ministry of Interior – Kingdom of Saudi-Arabia (with UK partner):**
  In total **85** VSAT stations; network with end-to-end encryption; implemented in 2014; extension contract Oct'2019 for upgrade with encryption and further maintenance support;
- ….

Global ATM / ATC network experience

- **ATC network SIDACTA for Bolivian MoD and BCAA - ASANA (with Thales Air Systems – France):**
  In total **18** VSAT stations in Bolivia; Roll-out started in **September 2018**;
  Redundant main station with 2 antennas – 15 fixed stations – 2 mobile stations (shelter); all fixed stations with terrestrial backup-link; additional with extended monitoring by Skyline DATAMINER; mainly VHF-radio-voice traffic (VHF-Radio: Jotron Norway) and Radar-data traffic (Radar: Thales France) plus voice communication VCS (VCS: SITTI Italia);
- **ATC network for ASECNA in Africa (with AERONAV – Canada):**
  In total **39** VSAT stations; Implementation phase 1 started with begin of **Q3/2018**;
  2 main stations and 37 remote stations with mesh function delivered in 2018; mainly IP-traffic for ADS-B service (for ADS-B service sub-system from INDRA Spain);
- **ATC network for ENNA in Algeria (with INDRA - Spain):**
  In total **26** VSAT stations with modem redundancy; national network under actual contract; complete modem package delivered to INDRA for further system-integration in **03/2019**;
- **ATC network for SADC-2 & NAFISAT in Africa (with ATNS – South Africa):**
  In total **31** VSAT stations; handed over after passed FAT to ATNS in 03/2016 for roll-out;
- **ATC network for ATNS/IVSAT in South Africa (with ATNS – South Africa):**
  In total **21** VSAT stations; national network handed over after passed FAT to ATNS in 04/2016;
- **Further ATC network in Africa & America & Asia (with various customers / partners):**
  Networks in *Nigeria* (NAMA), *Egypt* (NANSC / INEO), *Angola* (ENANA), South & Central America (i.e. international REDDIG-2 / INEO), Central America (i.e. international MEVA-3 / FREQUENTIS), Paraguay and Ecuador (with INDRA), Afghanistan, Iraq, Azerbaijan, …..;