Straalverbindingen

Serieus alternatief voor kabelinfrastructuur ?

Erik van der Made

15 September 2016

Agenda

A. Achtergrond en toepassingen van straal
B. De techniek
C. Betrouwbaarheid en spectrum analyse
D. Connectie alternatieven voor straal
E. SAF projecten in de Benelux
F. Conclusie

A. Achtergrond en toepassing

straalverbindingen

- Bandbreedte, flexibiliteit, redundantie
- Beschikbaarheid PtP en PmP frequenties

Toepassingen

- Flexibele backhaul voor mobiele netwerken, (W)ISPs, VNO's
- LAN-LAN verbinding voor 'multi locatie' organisaties
- Bedrijven(terreinen) en huizen in 'buitengebieden'
- (HD) camerabewaking op (industrie) terreinen (PmP)
- (HD) camerabewaking in openbare ruimtes (OOV)

B. Achtergrond en toepassing

straalverbindingen

- Bandbreedte, flexibiliteit, redundantie
- Beschikbaarheid PtP en PmP frequenties

Toepassingen

- Flexibele backhaul voor mobiele netwerken, (W)ISPs
- LAN-LAN verbinding voor ‘multi locatie’ organisaties
- Bedrijven(terreinen) en huizen in ‘buitengebieden’
- (HD) camerabewaking op (industrie) terreinen
- (HD) camerabewaking in openbare ruimtes (OOV)

- Offshore projecten
- Broadcast projecten (vast naar flexibel)
- Internationale lange afstand connecties

C. Techniek achter straal

1. Radio frequenties
2. Zichtverbinding
3. De componenten
   1. Baseband modem/interface (IDU)
   2. Radio (ODU)
   3. Antenne’s
4. Topologie Straalverbinding
5. Capaciteit en Betrouwbaarheid

1. Spectrum Straalverbindingen

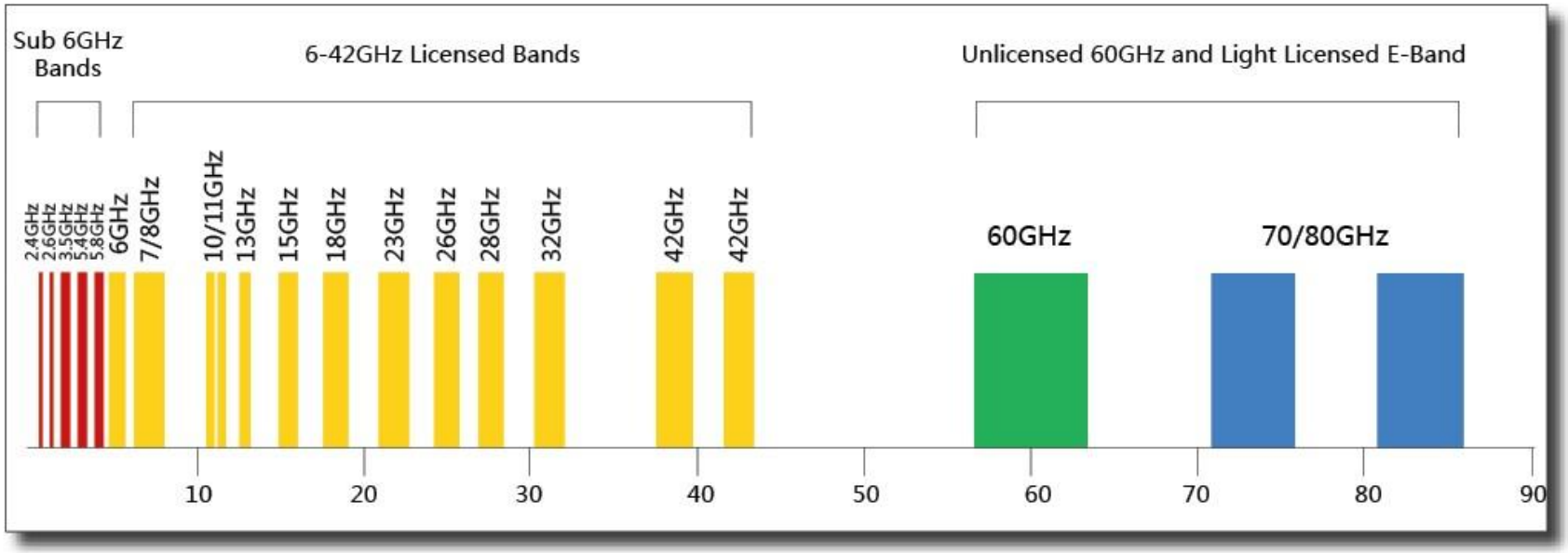
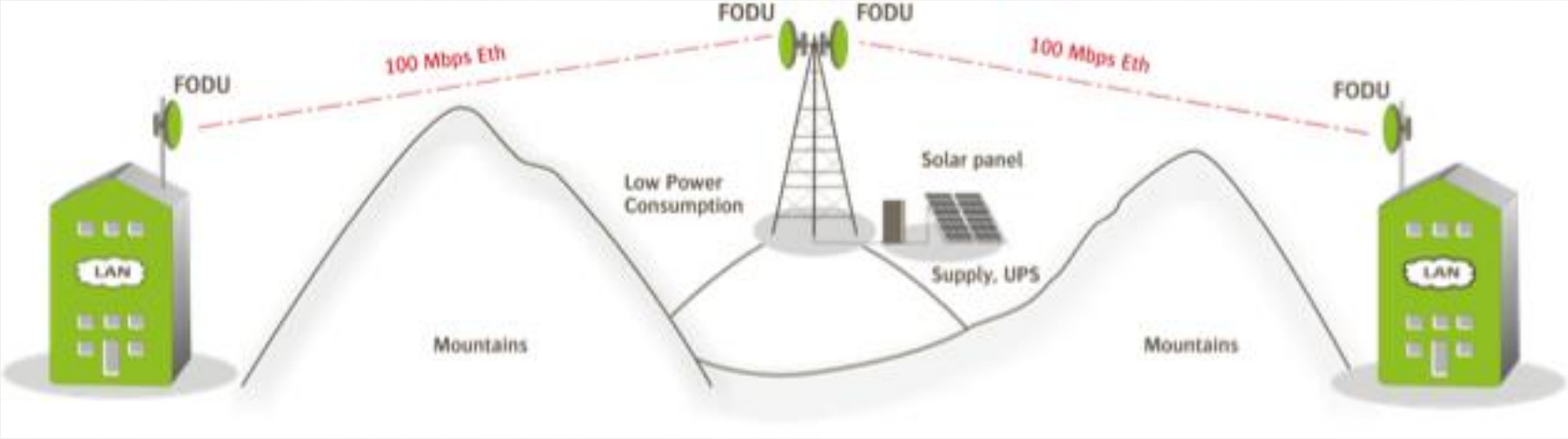


Figure 2. Frequency bands for microwave radios.

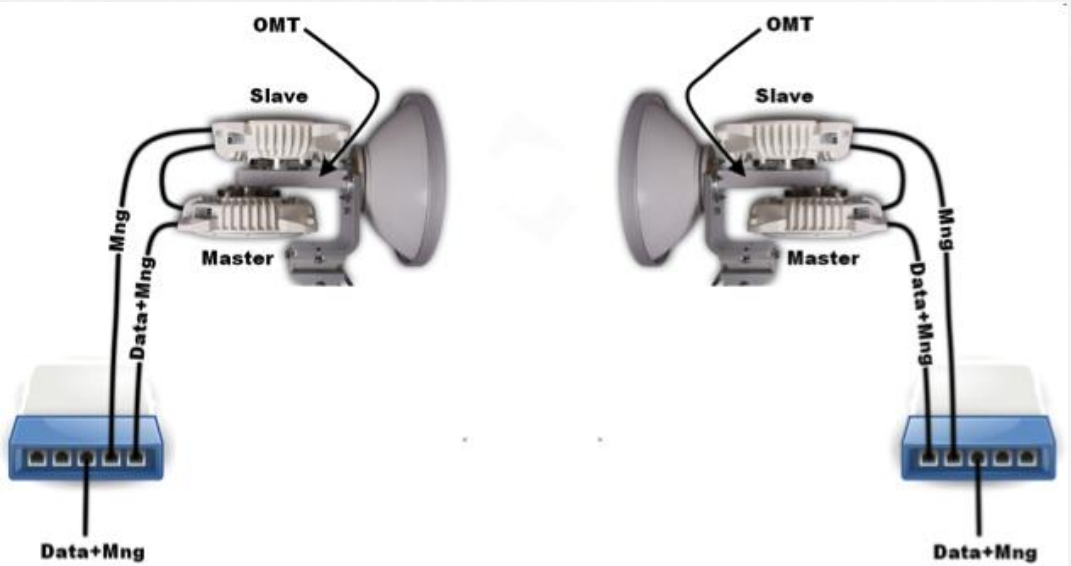
Licentie NL: 618 euro eenmalig
Jaarlijks: 52-455 euro

2. Line of Sight (zichtverbinding)

- Vrije zendkolom
- Opstelpunten
- Indirecte zichtverbinding



3. Componenten Straalverbinding

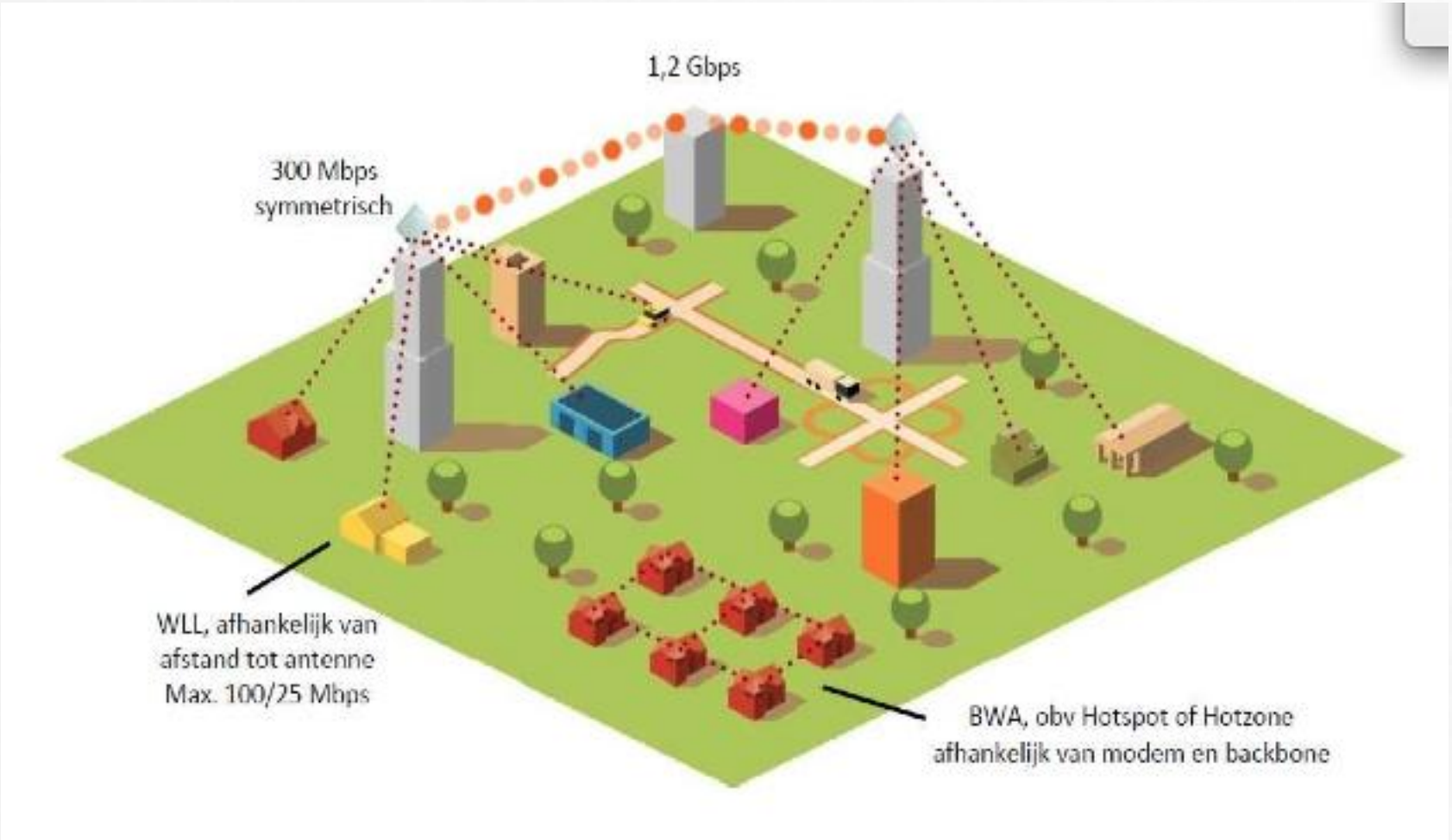


1+1 HotStandBy
2+0

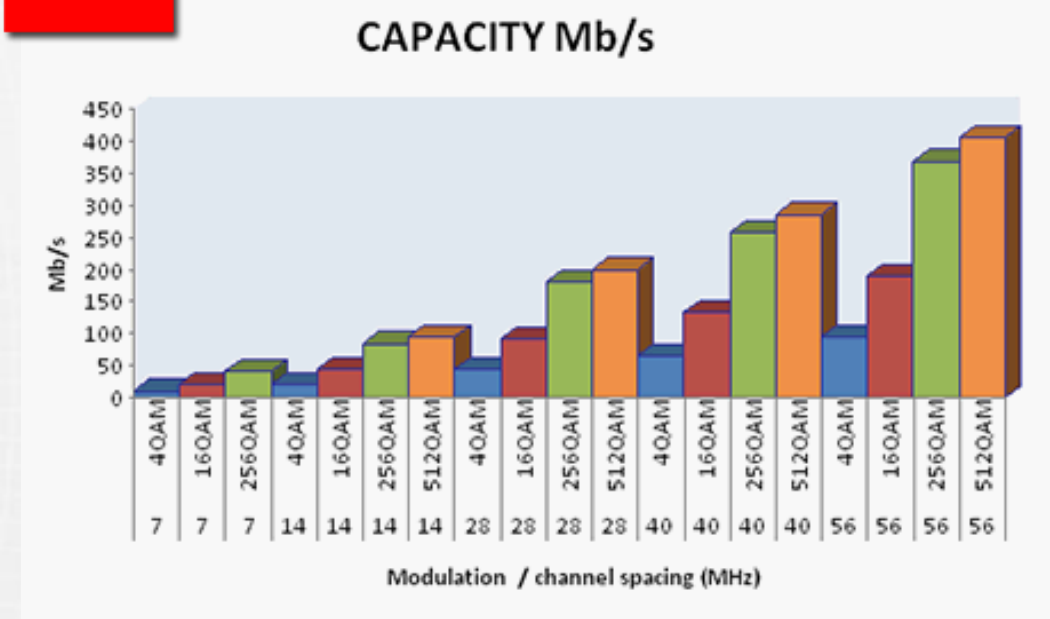
Full outdoor

4. Topologie Straalverbinding

Ster netwerk (PtP, PmP)
Ring netwerk



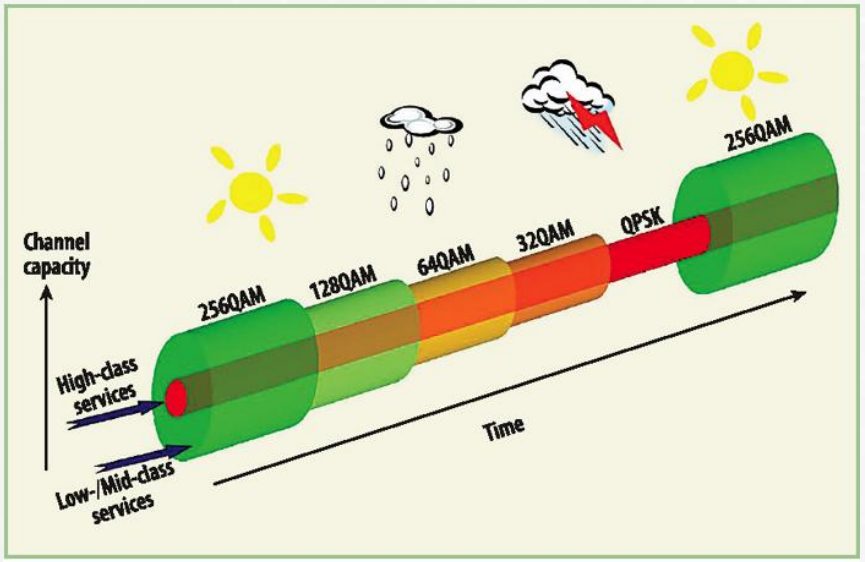
5. Capaciteit en betrouwbaarheid (1)



Modulatie
Kanaalbreedte

Gigabit/s Straalverbinding beschikbaar

MTBF > 5 jaar garantie
Weer
Signaalsterkte
99,999% beschikbaar



1. Adverse weather conditions can decrease cellular channel capacity, which most affects low- and mid-class services.

Betrouwbaarheid (2)

(Externe) interferentie
Installatie en Antenne uitrichting

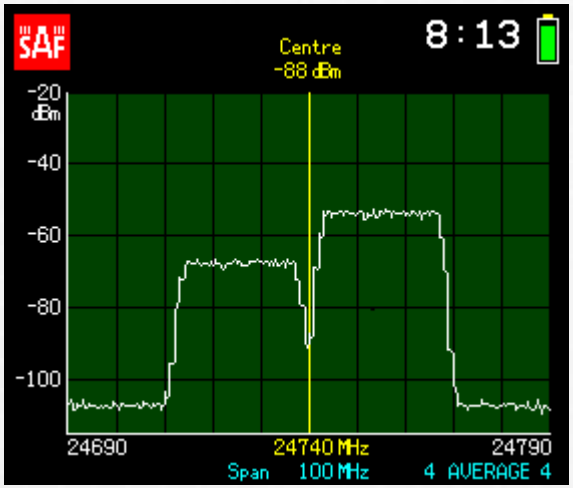
Spectrum Analyzer belangrijk hulpmiddel

Microwave Spectrum Analyzer

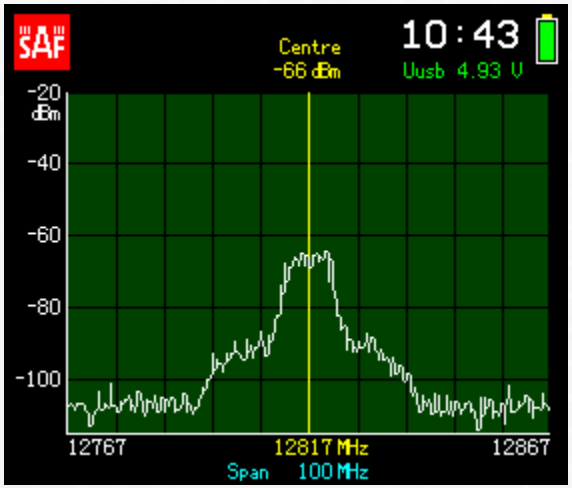
- Compact
- 2-40Ghz
- Nauwkeurig
- Simpel
- Zichtverbinding verificatie
- Betaalbaar

Visuele weergave van spectrum Analyses

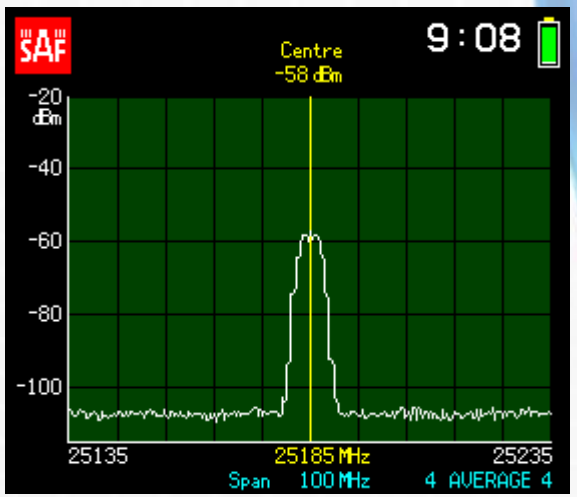
Adjacent channel interference



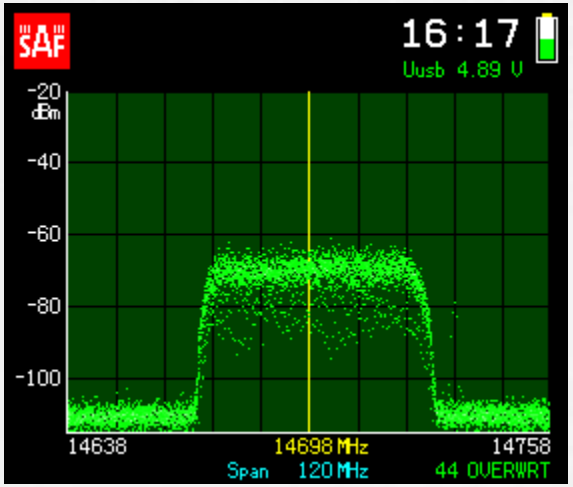
Damaged transmitter



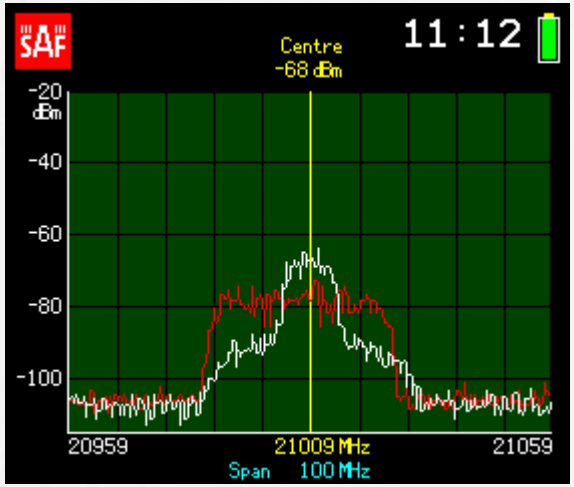
7 MHz channel



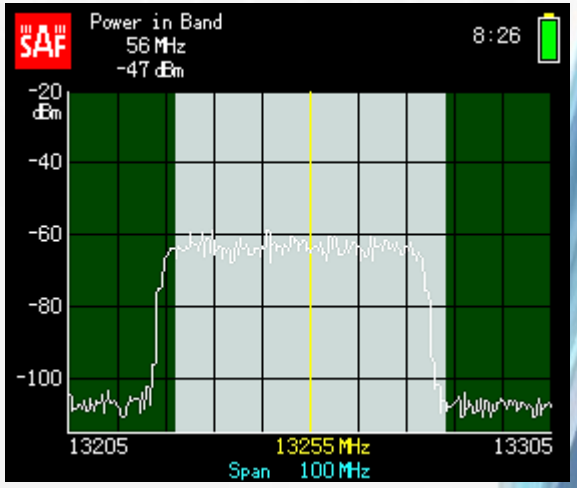
Multipath



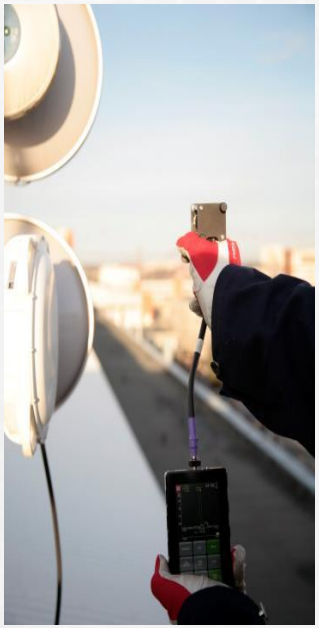
Reference Mask



Misconfigured Radio



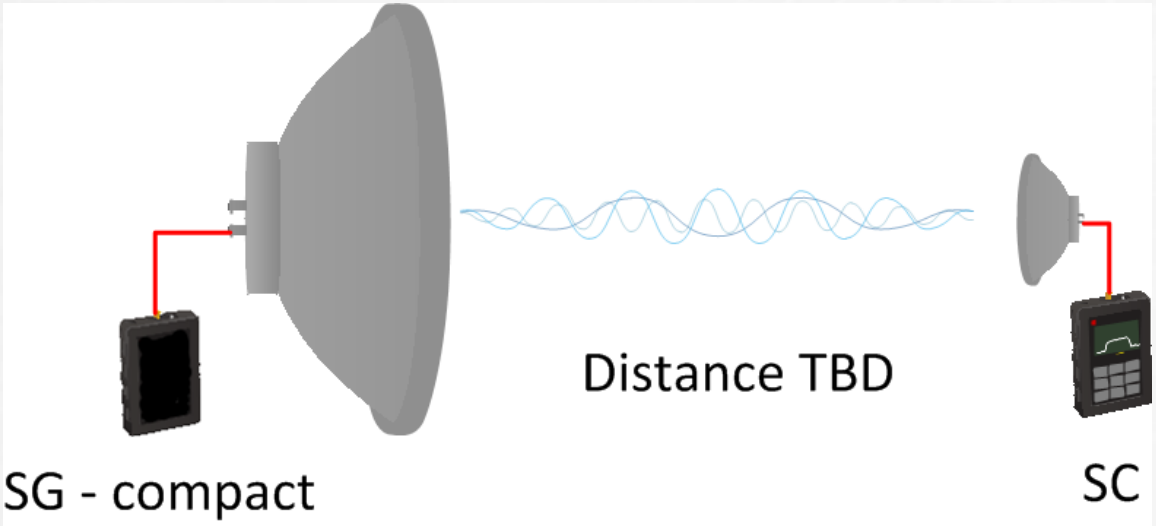
3 manieren om Analyzer aan te sluiten



Met waveguide adapter

Met Horn antenne (meer dBi)

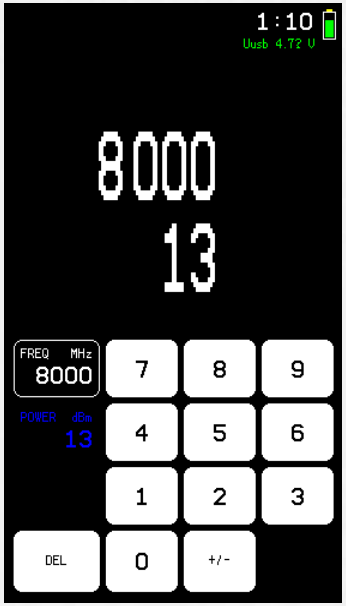
Met (bestaande) schotel antenne

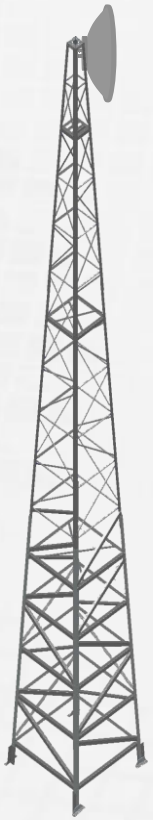


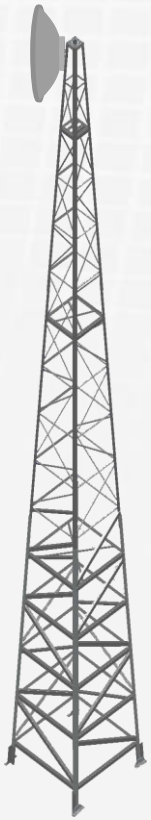
Nieuw: Signal Generator en Spectrum Compact:

exacte bandbreedte berekening op locatie

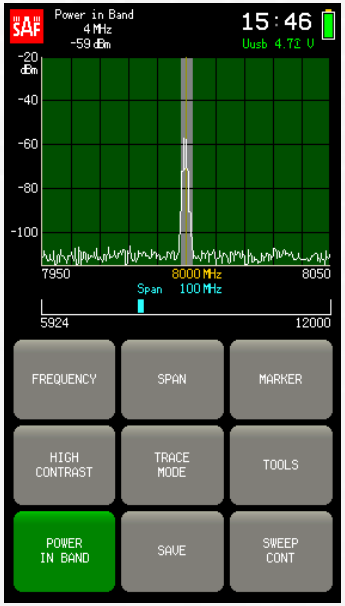
Signal Generator (SG)







Spectrum Compact (SC)



Nieuw: E-band 70-87Ghz Spectrum Analyzer

worlds first compacte analyzer for Gigabit links

P/N	JOSSAP80
Frequency range	70.000 - 87.000 GHz
Input power range	-90 to -30 dBm
Max input power	0 dBm
RBW	10 MHz
Min. Span	1 GHz
Max. Span	full bandwidth
Sweep speed	0.5s @ 1 GHz Span
Accuracy	+/- 1 dB* +/- 3 dB**
Input	WR 12
Interface	micro USB 2.0 (1.1)
Battery	2 x 2380 mAh Polymer Lithium-ion
Battery life	up to 3h
Operating temperature	-15ºC to +55ºC / 5ºF to 131ºF
Dimensions	147 x 83 x 34 mm / 5.79 x 3.27 x 1.34 in
Weight	0.57 kg / 20.11 oz

JOSSAP80: IP54

* Guaranteed at 21ºC/70ºF CW signal

** Guaranteed throughout all the temperature range

D. Connectie alternatieven (1)

Laag 1 medium	Technologie	Max. Capaciteit Mb/s	max Afstand km
koper	xDSL	20/2	3,5
koper	VDSL(2)	50/6	2
koper	G.Fast	250/250	0,2
coax	DOCSIS 3.0	200/100	nvt
Glas	GPON	2400/1200	20
Satelliet	Ka band	20/10	nvt
Mobiel	LTE	50/50	3
Straal (operator)	Licentieband	1000/1000	80
Straal (eindgebruiker	vrije band	450/450	12
Straal (PmP, TDD)	Licentieband	100	20
Straal (PmP, TDD)	vrije band	100	8

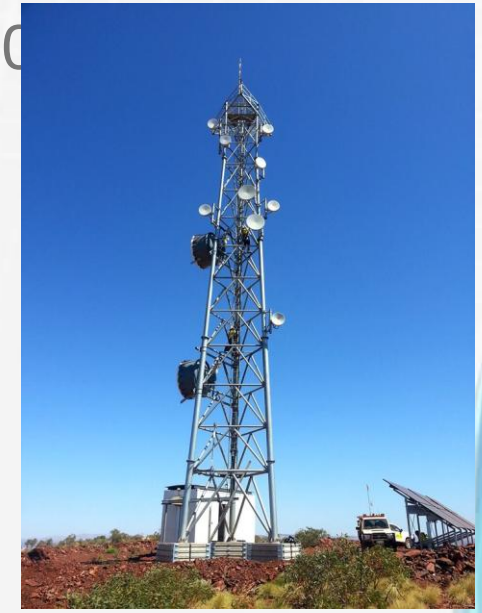
D. Connectie alternatieven (2)

Laag 1	Betrouwbaar	Aanlegkosten (relatief)	Overboeking	Spectrum	Latency
koper (xDSL)	Kabelkwaliteit/breuk?	laag/gemiddeld	ja	nvt	gemiddeld
koper (VDSL(2)	Kabelkwaliteit/breuk?	hoog	ja	nvt	gemiddeld
koper (G.Fast)	FM kabel interferentie	hoger	ja	nvt	gemiddeld
coax	Kabelkwaliteit/breuk?	laag	ja	nvt	gemiddeld
Glas	breuk?	hoogst	ja/nee (VPN)	nvt	laag
Satelliet	weer, afstand satelliet	laag	ja, groot	Ka band	hoog
LTE	weer, afstand, LoS	laag	heel groot	LTE banden	gemiddeld
Straal (operator)	weer, 99,99+%	laag	nee	6-43 Ghz	laagst
Straal (eindgebruiker)	weer, interferentie	laagst	nee	5, 17, 24 Ghz	laag
Straal (PmP, operator)	weer, 99,99+%	laag	mogelijk	3.6 Ghz	gemiddeld
Straal (PmP, eindgebruiker)	weer, interferentie	laagst	mogelijk	5Ghz	gemiddeld

SAF confidential

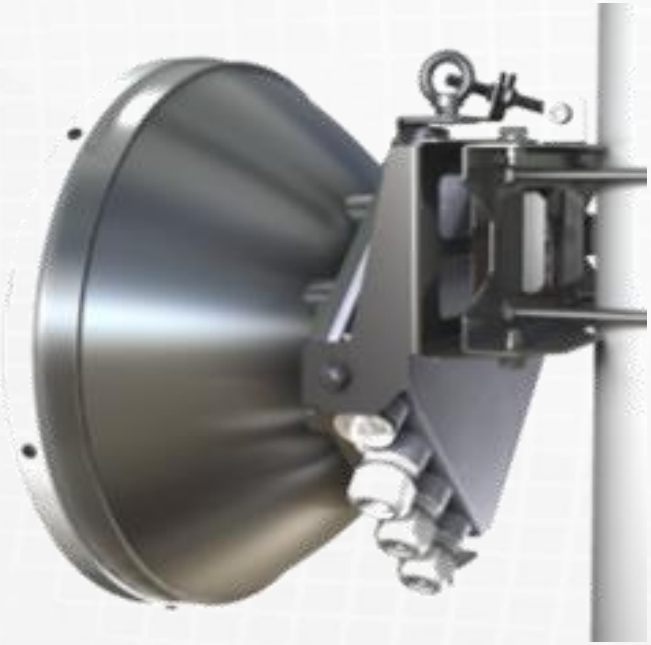
Toepassing SAF straaloplossing in Benelux

1. Bedrijventerreinen met 17/24Ghz Freemile
2. Landelijk Backbone netwerk in broadcast sector
3. Verbinding 1+1 van Harlingen naar Terschelling
4. Campings en Jachthavens (backhaul voor Wifi netwerk)
5. Backhaul Politie (Belgie)
6. Broadcast network VRTB Belgie



Conclusies

- Straalverbinding (vaak) goed alternatief voor kabel
  (zeker als er nog gegraven moet worden)
- Zichtverbinding (Line of Sight) belangrijk
- Gigabit capaciteit klaar voor de toekomst
- Hoge betrouwbaarheid van straalverbindingen
- Aantrekkelijke CAPEX en lage OPEX

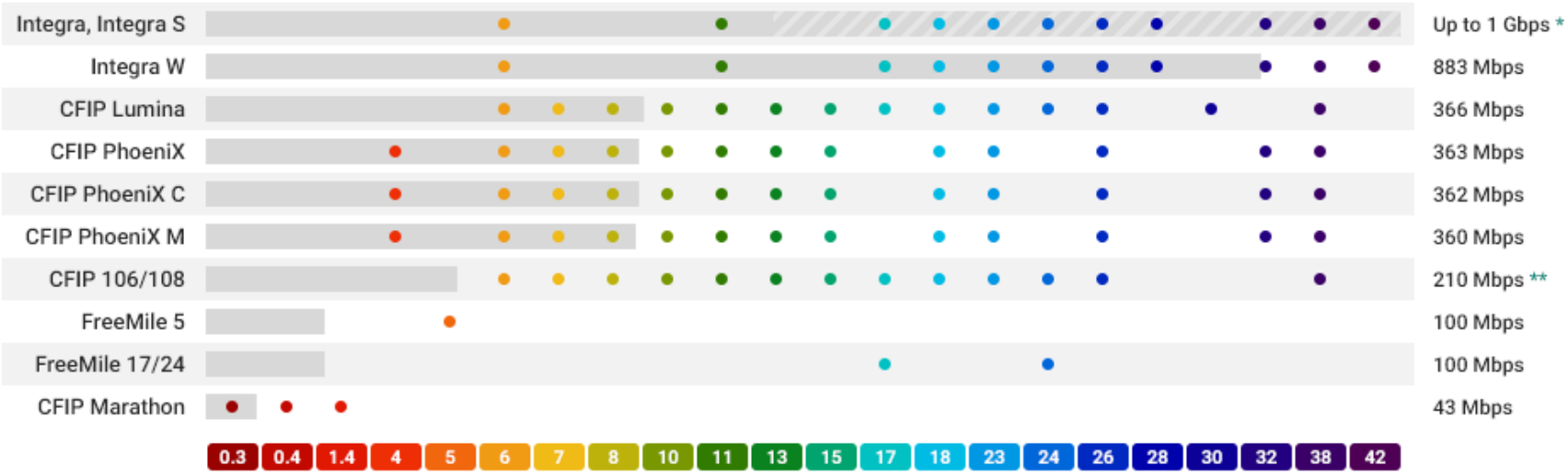


SAF Tehnika

Erik van der Made
Erik.vandermade@saftehnika.com
+31 6 42312633

Backup slides

Product summary



All mentioned capacities are in 1+0 configuration full-duplex.
The capacity is multiplied by number of radios in 2+0 / 3+0 / 4+0 configurations
* 474 Mbps without Header compression ** 105 Mbps (FDD), 210 Mbps (TDD)

Integra series, quick comparison

	Integra, Integra-S	Integra-W, Integra-WS
Modem	Up to 60MHz	Up to 112MHz
Tx power	Standard	High, with pre-distortion
Ethernet	Carrier Ethernet Network processor	Gigabit switch, unmanaged

6GHz, 11GHz

Integra, Integra-W	Integra-S, Integra-WS

Integra-W general summary

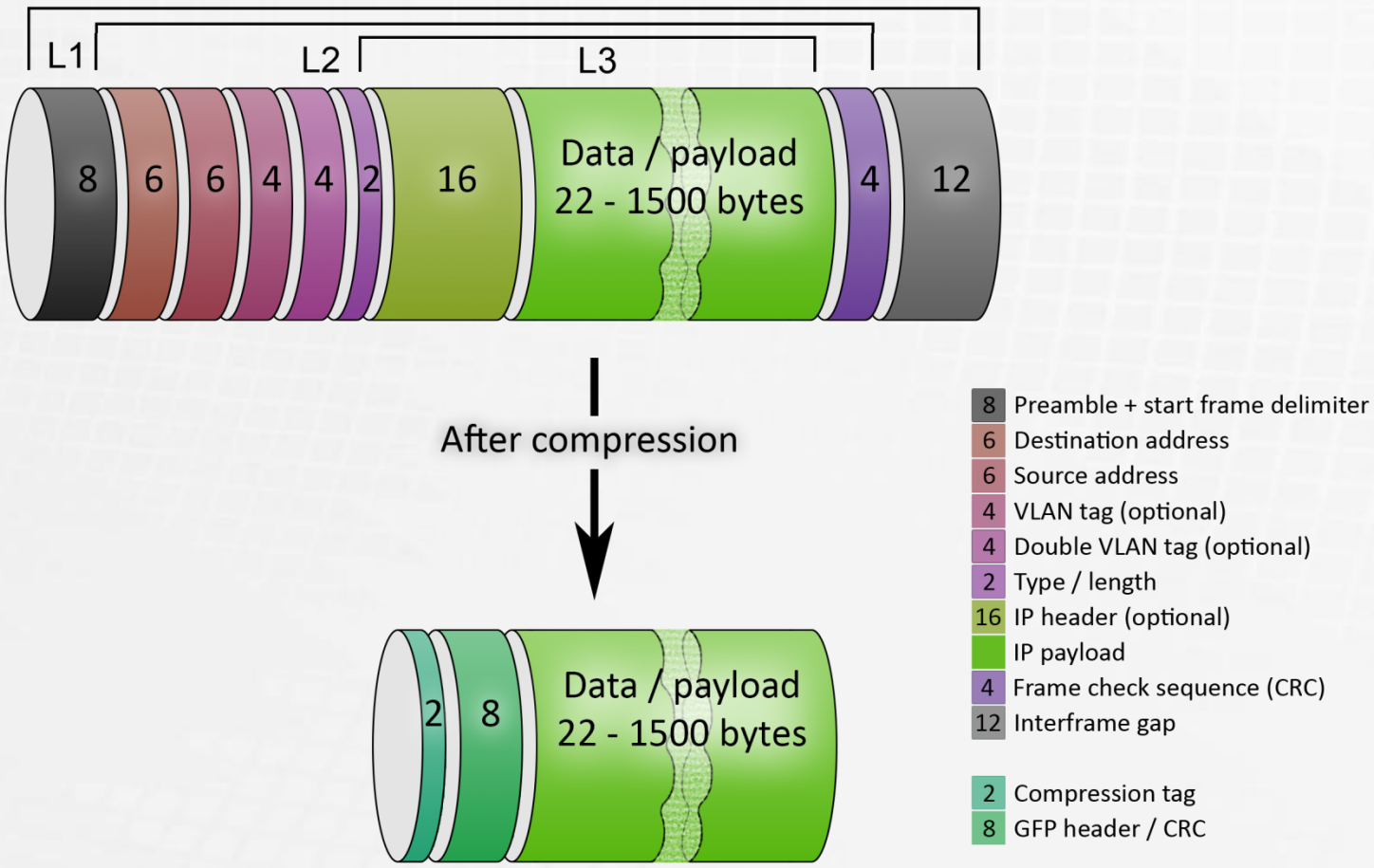
- **Max Capacity:**
  - Up to 481 Mbps in 60MHz Full Duplex 1+0 Configuration
  - Up to 883 Mbps (data rate) in 112MHz Full Duplex 1+0 Configuration
- **Frequency Band Support**
  - 15GHz, 17GHz, 18GHz, 23GHz, 24GHz UL, 26GHz, 38GHz, 42GHz and other
- **Supported Channel Sizes:**
  - ETSI: /28/40/56/80/112 MHz
  - FCC /30/40/50/60/80 MHz
- **Supported Modulations:**
  - 4QAM through 1024QAM with Hitless ACM
- **Output Power:**
  - Up to +33dBm at 4QAM with ATPC
- **Power supply:**
  - - 20V … - 60V with SAF Power Injector

Integra-W benefits

- Wide channel bandwidth support, up to 112MHz
- Higher Tx power for higher modulation levels with advanced pre-distortion algorithm
- Secure Out-of-band management
- Ethernet Synchronization for LTE support
- PoE over Electrical GE port
- User configurable traffic interface port:
  - Electrical
  - SFP for FO

Integra & Integra-S: Header compression

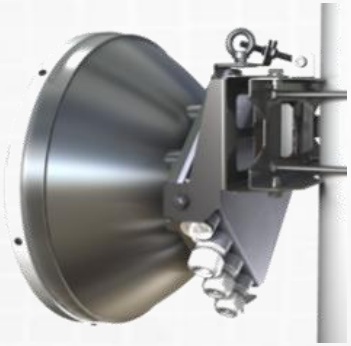
- Compressed data: headers and overheads:



Licensed product line:

- Licensed CFIP product line, providing up to 366Mbit/s Ethernet capacity per radio

CFIP PhoeniX Split Mount



Integra FODU

CFIP Marathon FIDU

CFIP PhoeniX C Split Mount

CFIP Lumina FODU

CFIP PhoeniX M Split Mount

CFIP-108 FODU

Unlicensed product line:

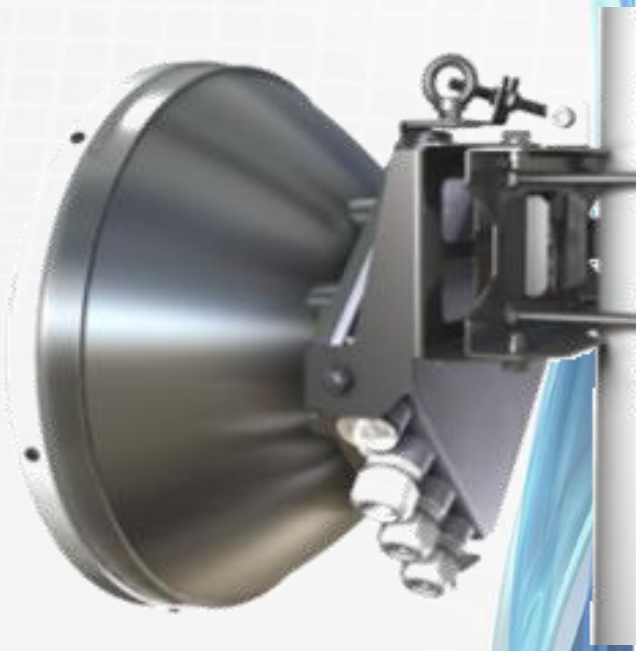
- Unlicensed SAF FreeMile product line, a new generation license free 5.8/17/24GHz ISM band radios for Ethernet packet data and E1 voice transmission

SAF FreeMile 17/24 Ghz

SAF FreeMile 5.8 GHz MIMO

Integra G Feature summary

- **Max Capacity:**
  - Up to 456 Mbps in 56MHz Full Duplex 1+0 Configuration
  - Up to 474 Mbps in 60MHz Full Duplex 1+0 Configuration
  - Up to 930 Mbps in 60MHz Full Duplex 2+0 Configuration
  - Up to **1.6 Gbps** full duplex with header compression
- **Frequency Band Support**
  - 15GHz, 17GHz, 18GHz, 23GHz, 24GHz UL, 25/26GHz, 38GHz*, 42GHz
- **Supported Channel Sizes:**
  - ETSI: 3.5/7/14/20/28/40/56 MHz
  - FCC: 5/10/20/30/40/50/60 MHz
- **Supported Modulations:**
  - 4QAM through 2048QAM with Hitless ACM
- **Output Power:**
  - Up to +20dBm at 4QAM with ATPC
- **Power supply:**
  - - 20V … - 60V with SAF Power Injector
- **Carrier grade Ethernet**
  - Built-in 6-core network processor
  - SyncE
  - Header Compression
  - 2+0 link bonding



FreeMile technical specifications (1)

Frequency range, GHz:

- **17 (17.1-17.3 GHz)** ERC 70-03 (100MHz offset)
- **24 (24.05-24.25 GHz)** ERC 70-03 (100MHz offset)
- **24 (24.15-24.25 GHz)** UK Ofcom IR2030 (70MHz offset)

Channel bandwidths:

- **10/30 MHz**

Max capacity:

- **100Mbps Ethernet + 2E1/T1**

Different modulations:

- **QPSK/16QAM/32QAM/64QAM**

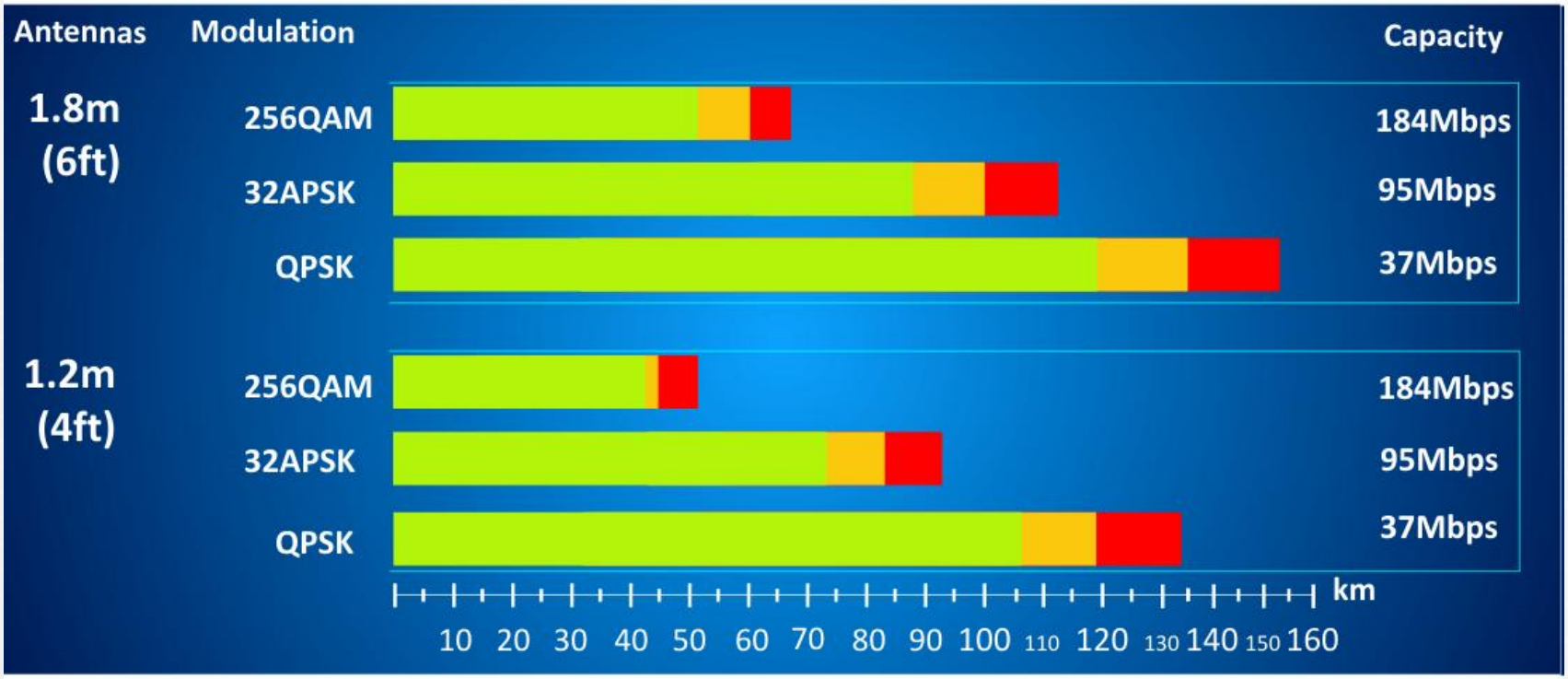
SAF Spectrum Compact

- Compact Design
- **Very easy to use!**
  - Resistive LCD touch-screen allows working even in gloves
  - No laptop required for on-site use
  - Battery life up to 4 hours
- Best sensitivity: **-105 dBm**

- Wide frequency band coverage:
  - **6** / **7** / 8 / 10 / **11** GHz
  - 10 / **11** / **13** / **15** / 17 GHz
  - 17 / **18** / **23** / **24** GHz

CFIP calc example

6GHz 30MHz RAINZONE D

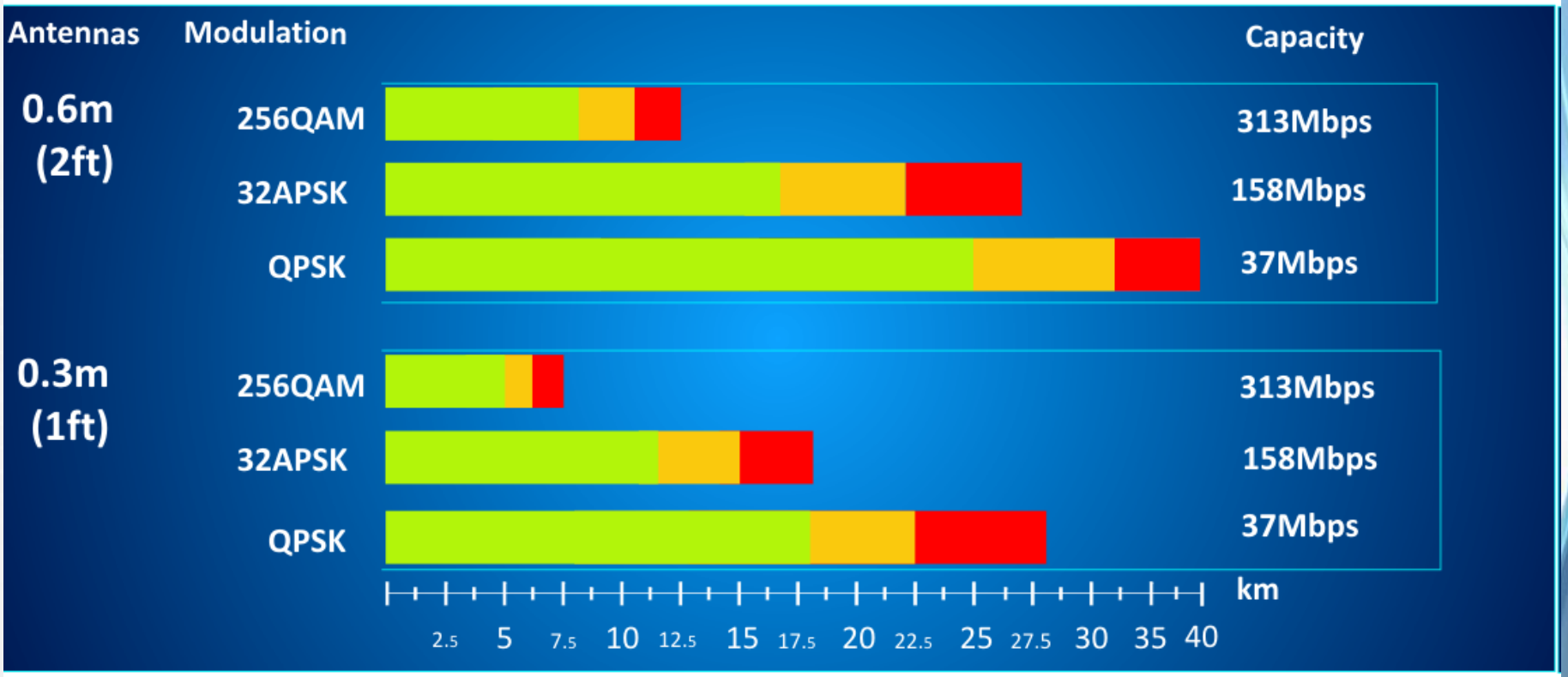


	Downtime per year, hrs	Availability per year, %
Hi	(0; 0.5)	(99.99429; 100)
Mid	(0.5; 1)	(99.98858; 99.99429)
Lo	(1; 2)	(99.97717; 99.98858)

* The results are obtained for 6GHz frequency band using ITU-R Rain zone D=19mm/h. The errorless ACM feature will automatically switch to lower modulation during strong fading

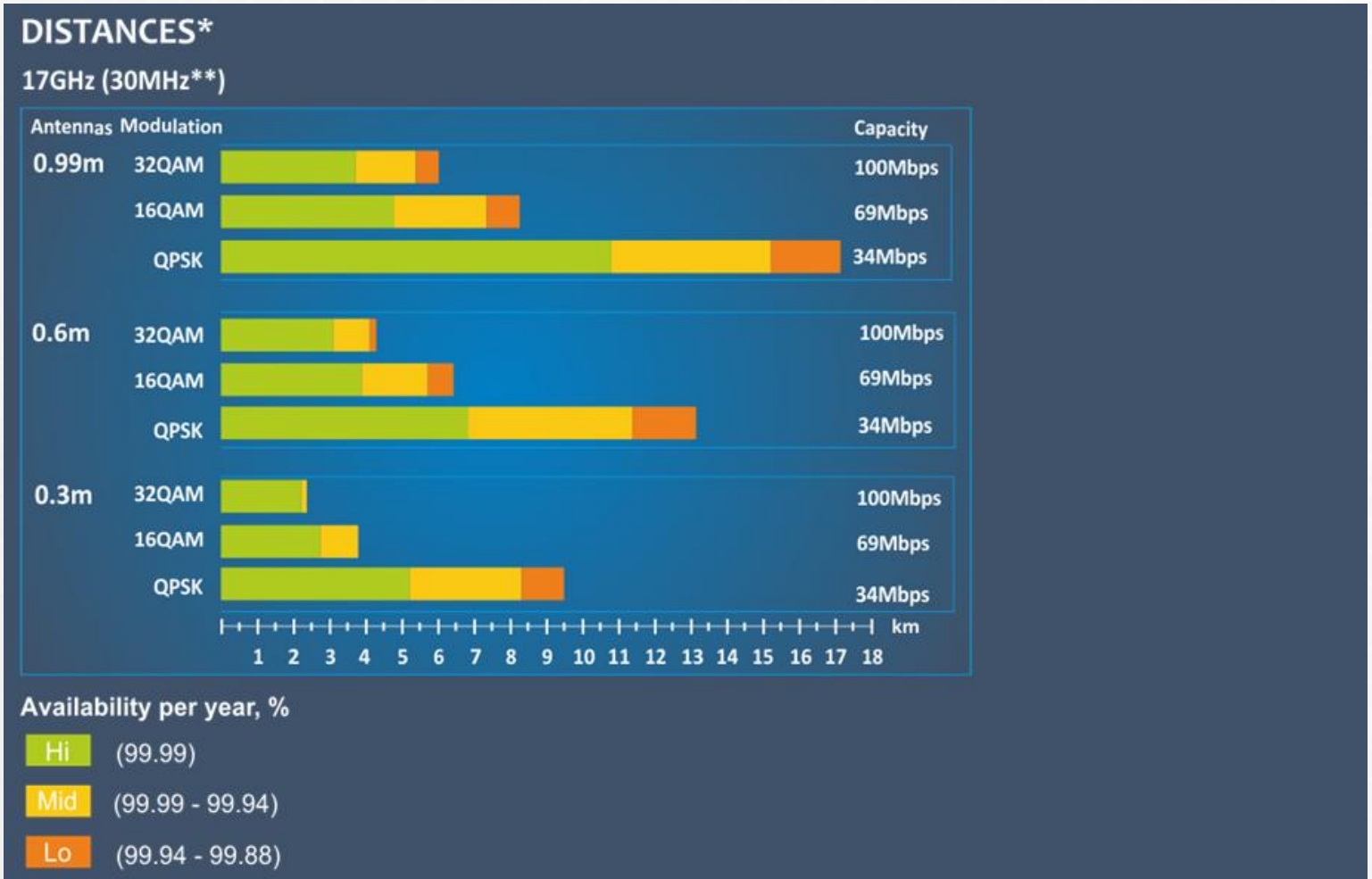
CFIP calc example

23GHz 50MHz RAINZONE D Annual temperature = 59°F



	Downtime per year, hrs	Availability per year, %
Hi	(0; 0.5)	(99.99429; 100)
Mid	(0.5; 1)	(99.98858; 99.99429)
Lo	(1; 2)	(99.97717; 99.98858)

CFIP calc example (SAF FreeMile 17)



* Results are obtained using ITU Rain zone G=30mm/h. The errorless ACM feature will automatically switch to lower modulation during strong rain fading moments.

** At 10MHz channel bandwidth with QPSK modulation the distance is about 1km longer. For detailed link planning please download SAF path calculator at www.saf-freemile.com

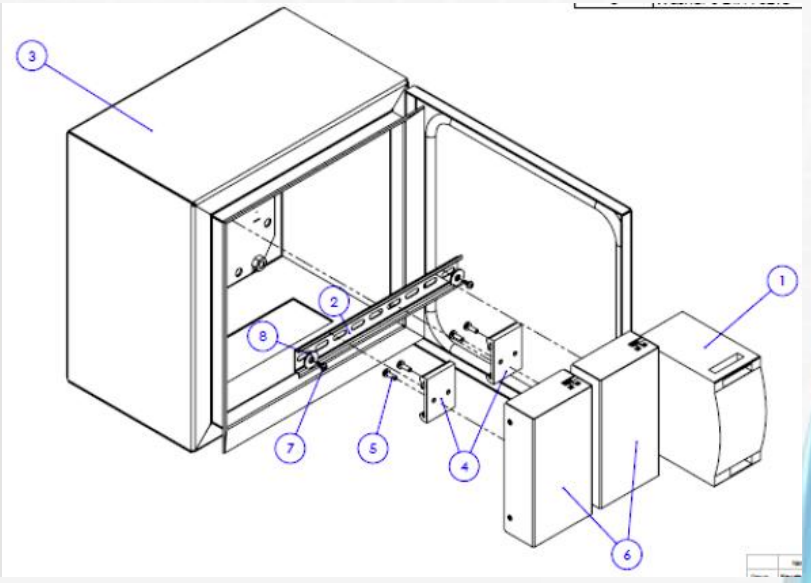
Outdoor Branching Unit (4+0)

Benefits:

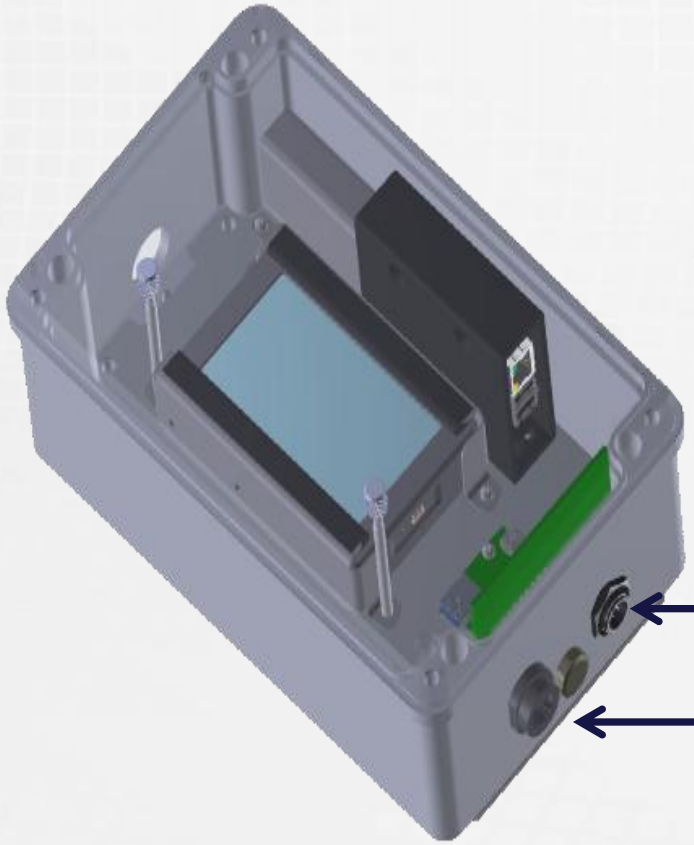
- Multiple radios to single antenna
- Multiple radios to one antenna, versus coupler:
  - 2 radios per pol: save 2.5 dBm per radio, or 5 dBm per link
  - 4 radios per pol: save 6 dBm per radio or 12 dBm per link

Shelter-free-installations

- Application:
  - Outdoor enclosure with din-rail for PoE, AC/DC adapter, switch, fuse
- Ideal product
  - SAF assembled enclosure



Spectrum Compact 24/7 monitoring solution



Benefits:

a) 24/7 real-time monitoring
b) SC device doesn`t have to be modified
c) Easily mountable
d) EMC protected
e) Free PC software