

SES Proprietary and Confidential



SES Infrastructure

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Launch manifest 2019 - 2021







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SES NETWORKS

 WHAT WE DO
 Provider of global managed data services

 WHAT WE DO
 Enabling high-performance networked communications virtually anywhere

 MARKETS
 Image: Communication of the communicatio of the communicatio of the communication

MARKETS WE SERVE

MARITIME

D CLOUD



ENERGY



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Markets we serve

TELECOM (Telco/ISP/CSP/MNO)

High-performance network infrastructure and services, capacity on demand, and cost-effective mobile backhaul solutions. Everywhere.

MARITIME

Global data network and communications solutions for broadband connectivity to any vessel. Anywhere.

AERO

Next generation, satellite-enabled mobility solutions delivering the highest possible data throughputs and quality of experience.

ENERGY

Secure, high-performance network connections for oil and gas, mining, hydro, wind and solar energy companies and their ecosystems - no matter how remote or widespread.

GOVERNMENT

30 years of experience in delivering end-toend managed network, application services and provisioning of critical communications for defence and security, disaster response, humanitarian applications or institutional missions.





disaster response

At a Glance



in numbers



Capable of delivering



Scalable connectivity ranging from 100 Mbps to 1 Gbps

>1,000,000

Passengers of Royal Caribbean Cruises per year

GovSat-1 transponders

Provides over





Provides connectivity to about

connected planes today

Our customers serve about of all global connected planes



>40 emergency.lu



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SES Networks Differentiated portfolio

Enabling clients with customised, end-to-end solutions

Delivering tailored solutions across a wide range of growth applications Providing reliable and secure connectivity across the value chain



Differentiated portfolio

SES Networks managed solutions

TECHNOLOGY LED			SOLUTION LED
		• Comprehensive portfolio	 Total outsource Complete risk transfer Remove operational focus Consumption based billing Scalable resources Self-provisioning
Assured delivery	 Transfer of risk Fully integrated SLAs One-stop shopping One "neck to grab" 	 Comprehensive portiono Underpins data business models Secure cloud experience Optimized cloud experience Drives data adoption 	SES Networks Managed Solutions
 Operational support Minimal baseline Product Support 	Managed Services	Value Added Services	managoa corationo

OVERALL VALUE

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Engagement model



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Global Government

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TITLE

SES NETWORKS GLOBAL GOVERNMENT



Enabling high-performance networked communications for missions on land, at sea and in the air

40 YEARS OF EXPERTISE

WHAT WE DO

WHAT WE DO

Serving 58 government clients across 29 countries

Serving 50 clients across 15 US agencies Dedicated regional and global government sales offices in 26 countries

SES Networks Global Government Differentiated portfolio





WHAT WE OFFER

- Widebeam and GEO/MEO HTS capacity and secure teleport services
- C/Ku/Ka and Military frequency capacity
- Fully managed end-to-end service to the end customer (Mbps + services)



WHAT WE ENABLE

- Civilian and defence applications such as defence, security and information gathering purposes are delivered on globally redundant, secure and reliable networks
- Developing satellite-based solutions for humanitarian aid, e-governance, e-learning, etc.



HOW WE DIFFERENTIATE

- Unique portfolio of multi-orbit multi-band services and global access network
- Global managed services
- Preparing for the future with O3b mPOWER

SES Networks Global Government

Who we serve

Drawing on over four decades of experience, SES Networks Global Government's purpose is to provide bandwidth, end-to-end satellite communications solutions and hosted payload opportunities to Government, Intelligence and Civilian agencies.

- MOD's (all Arms and Services)
- State and Federal Governments
- Ministry of Foreign/External Affairs
- Ministry of Home/Internal Affairs
- Paramilitary Forces
- Disaster Management Authorities
- Local In Country UN Heads/Program Directors
- Emergency services, Fire, Police
- Search and Rescue



SES Networks Global Government

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Mission profiles

SES Networks Global Government provides a wide range of services supporting the following mission profiles:



- Intelligence, Surveillance and Reconnaissance (ISR) missions
- Manned and Unmanned airborne missions
- Navy and Coast Guard connectivity
- ▲ Land based forces
- Communications on the Move (COTM)
- ▲ Border protection
- ▲ Homeland security
- ▲ Morale, Welfare and Recreation
- ▲ Humanitarian Missions
- ▲ Disaster Recovery
- ▲ Expeditionary Forces
- ▲ VIP travels
- Embassy Networks

Changing the government landscape



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SES Networks Global Government

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Serving governments worldwide



Government defence overview







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Partnering to Create More Value for Governments

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SES & ECOSYSTEM OF PARTNERS

DEDICATED GO-TO-MARKET

Tailored to country requirements. | Official certifications

OPERATIONAL SUPPORT

Secure cloud services. Data analytics. High-grade security

INNOVATIVE SERVICE MODELS

Instant & guaranteed access. De-risk the investment. Joint Venture Models

TECHNOLOGY & SOLUTIONS Throughput, Latency, Coverage, Flexibility, Resiliency

Managed Services Designed for Defence and Security Needs



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SES^A Networks

SKALA



THE SES SKALA GLOBAL PLATFORM OFFERING

A unique combination of ground system technology, advanced satellite capabilities and service lifecycle expertise that enables the creation and delivery of tailored services across a diverse range of use cases

Putting the Pieces Together

FLEXIBLE, MULTI-BAND SATELLITE ARCHITECTURE





- Addresses dual requirements of ubiquitous coverage and faster data speeds
- Augmenting HTS with legacy wide beam technology for broader coverage in less dense areas

A FLEXIBLE AND SCALABLE **GROUND SYSTEM**



- ▲ Manages a diversity of frequency bands and satellite types
- A Real-time network performance monitoring ensures bandwidth is optimised and SLAs are met
- High performance remotes

A RANGE OF SERVICE MODELS



- ▲ Supports multiple service delivery models, including platform services, end-to-end managed network services
- Enables flexible commercial options, reducing complexity and risk

High-Throughput Satellite (HTS) as a Game Changer



- The concentrated spot beams of HTS systems can transmit up to 20 times greater data throughput as compared to wide beam satellites
- A reduced cost per bit translates into the ability to deliver highquality broadband services at a lower cost across the Skal Global Platform
- Flexible analogue or digital gateway connections

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The Skala Global Ku-band Network





Aggregate Ku-Band Coverage

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SES HTS Coverage

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Gateway Scale

- Robust, high-power server infrastructure deployed and replicated at global gateways to ensure long term, futureproof scale supporting tens of thousands of terminals
- ▲ Unique access to complex HTS gateway infrastructure
 - Many gateways required for single HTS asset
 - Redundancy on satellite and ground infrastructure
- Gateways standardised for security and modularity, each of the gateways are connected to robust MPLS network with access to thousands more points of presence across the globe

A High-Performance System on the Ground

FLEXIBLE HUB ARCHITECTURE

- Able to manage bandwidth across multiple spot beams and multiple satellites
- ▲ Carrier-grade resiliency and reliability
- Support for multiple satellite bands, including Ka, Ku, C and X
- ▲ Support for high aggregate symbol rates

NETWORK MANAGEMENT SYSTEM

- Visibility into network performance and activity via web-based interface
- Open APIs for simple integration into other management systems
- Sophisticated management of SLAs and global bandwidth pools

REMOTE PORTFOLIO

- Portfolio of remotes designed to support a wide range of data speeds, available in multiple form factors, including desktops, rack-mounts and router boards
- Supporting fixed, mobile and defence applications

SE:

Ground System Features

GLOBAL BANDWIDTH MANAGEMENT

The ability to manage a single bandwidth pool across a coverage area that spans multiple spot beams, including partitioning bandwidth into sub-networks based on geographic scope, quality of service, etc.

AUTOMATIC BEAM SWITCHING

Remotes can automatically cross multiple spot beams and gateways within a short period of time while maintaining a constant IP session, with no manual intervention. Multiple orbital slots allow for look angle redundancy at satellite level.

A NEXT-GENERATION NETWORK MANAGEMENT SYSTEM

Enables the management of complex, large-scale networks to ensure reliable, efficient and profitable network operations

Optimised to Address Multiple Verticals' Requirements

- ▲ Able to address stringent vertical-specific requirements
- A Range of deployment models removes complexity and risk
- Verticals are able to assume seamless communications coverage and focus on core business

GOVERNMENT

Seamless coverage across key geographies
 Automatic beam selection for naval vessels
 Scalable connectivity packages

ENTERPRISE

- Choice of bandwidth packages optimized for varying requirements
- Easy provisioning for onboarding sites or seasonal demand

MARITIME & ENERGY

- ▲ Remote coverage
- ▲ Customisable bandwidth
- Committed SLA per vessel
- Seamless movement between beams

 Manage bandwidth across a network that spans multiple beams, aircraft and end users
 <u>Ubiquitous coverage across</u> geographies

Flexible Service Options

Per Bandwidth Pool

BANDWIDTH POOLS CAN BE CREATED ACROSS MULTIPLE BEAMS, IRRESPECTIVE OF SATELLITE OR BEAM FOOTPRINT

- Different beams have different characteristics, but multiple beams are pooled together to allow ubiquitous SLA
- SLA exception in cases where a particular beam is loaded with more than 20% of traffic from single customer in multi beam environment

IN POOLED BANDWIDTH SCENARIO, A CONTENTION RATE IS DEFINED PER POOL OF BANDWIDTH

- Customer understands and accepts number of terminals in a pool of bandwidth cannot exceed the contention figure
- Customer understands that aggregate CIR of terminals cannot exceed total pool throughput

POOLED BANDWIDTH CUSTOMERS CAN HAVE TERMINALS MANAGED BY SES OR CHOOSE TO MANAGE CREATION AND TERMINALS END CHANGES BY THEMSELVES (SVNO).

- Limitations to package configurations are predefined and based on standard deployment of user tool
- Allows flexibility to take more management of end user terminals in high scale scenarios

Service Level Commitments

COMMITTED INFORMATION RATE ("CIR")

SES Commitment:

SES shall provide Service that meets the CIR set forth in the Service Order provided that the satellite terminals utilised by Customer comply with SES-recommended antenna size, modem specifications, including but not limited to FEC/Coding and modulation details.

Measurement:

CIR will be measured using the NMS or such other measuring tools SES deems appropriate to the Service.

Service Credits: SES shall provide Customer with a Service Credit proportional to the loss of CIR for each minute of the CIR Degradation Event.

NETWORK UPTIME

SES Commitment:

SES shall provide Service that meets or exceeds the Network Uptime set forth in the Service Order.

Measurement:

Network Uptime will be measured using the NMS or such other measuring tools SES deems appropriate to the Service.

Service Credits:

SES shall provide Customer a Service Credit for each minute of Network Outage that is below the Network Uptime commitment in a given calendar month.

Skala Global Platform delivers Mbps and Uptime SLA. SES will use all assets available to deliver the most appropriate solution at any time regardless of satellite, beam, gateway. UNIQUE COMBINATION OF MEO AND GEO SPACE ASSETS BOTH WIDE BEAM AND HTS, TO ENSURE THE BEST SERVICE AT THE BEST TIME NEXT-GENERATION GROUND INFRASTRUCTURE SOLUTION OPTIMIZED FOR HTS SUPPORTS FLEXIBLE AND SCALABLE BANDWIDTH DELIVERY

RANGE OF DEPLOYMENT OPTIONS AND LIFECYCLE SERVICES LOWERS OPERATIONAL COST AND RISK WHILE ENABLING A FASTER TIME TO SERVICE AND REVENUE SES^A Networks

SKALA GLOBAL PLATFORM HIGH AVAILABILITY SOLUTION WITH 24X7 SUPPORT AND GEO-REDUNDANCY FEATURES ENSURES A CONSISTENT END USER EXPERIENCE

ECOSYSTEM APPROACH PROVIDES ACCESS TO PARTNERS FOR VALUE-ADDED FEATURES AND FUNCTIONALITY WITHOUT INTEGRATION COST AND HASSLE


Strengthening our solution portfolio with SD-WAN

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SD-WAN defined

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SD-WAN defined



SD-WAN Solves Key Problems for our Customers



Improves resiliency

- Simpler solution for creating multi-access networks
- Links can be always-on or on-demand



Reduces capital and operating costs

- Uses general purpose
 "universal" CPE
- Minimises stranded bandwidth
- Eliminates high-touch network management



Mitigates network complexity

- Makes the network more programmable
- Automates service provisioning and equipment configuration
- Employs simpler, smarter monitoring and analytics



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Optimises application performance

- Infuses the network with application awareness
- Users determine own policies per application
- Example: Steers
 latency-sensitive traffic
 over MEO, latency tolerant traffic over GEO

SD-WAN Is about Creating Scalable, Simple, and Resilient

SD-WAN enables our customers to create an **application-aware, secure multi-access (or "hybrid")** network. It allows our customers to simply define application-level network policies that drive smarter, more efficient bandwidth utilisation, optimising application performance, minimising complexity, and reducing cost.



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SD-WAN Caveats

SD-WAN...

... is an **enabling technology** for existing SES products and services.

- **...** solutions **need to be designed** to fit customer requirements.
- **...** is generally a '**Brownfield' solution**, not a 'Greenfield'. At least for now...
- ••• technology is still in the early stages of maturity. For both the industry & SES.



O3b mPower

O3b mPOWER enables a new era of satellite-based data communications





Unserved markets need fibre-like connectivity

O3b mPOWER provides the reach and performance





Our journey with high-throughput, low-latency

MEO satellite communication systems



2014	2016	2018	2020	2022
O3b MEO start of service at 12 satellites	Mobility, Telco, Energy	Scale O3b MEO	O3b mPOWER	O3b mPOWER
	Government success	to 20 total satellites	development	start of service



O3b mPOWER evolution massive scale, performance, & flexibility

O3b mPOWER Augmentation







O3b mPOWER reach +/-50° Latitude covers 96% of global population





Future inclined plane orbits to cover the poles

SES Proprietary and Confidential | O3b mPOWER





- Fully digitised payload
- Electrically steered beam-forming (thousands per satellite)
- High throughput (to multi-Gbps) per end user
- Terabit per second scalable system
- Flexible forward-to-return throughput ratios
- Low latency MEO (<150msec)
- Inherent security & flexibility

3b mPOWER round systems and user terminals



- SES managed and/or private data gateways
- Open intelligent gateways, modems & antennas
- Advancing technologies (small, flat panel)
- ▲ High power, spectrum, bandwidth







Flat panel Terminal Solutions





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O3b mPOWER Adaptive Resource Control (ARC)

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O3b mPOWER

Adaptive Resource Control (ARC) system

Dynamic management & control

- Real-time beam forming, power & spectrum
- · Precision tracking, handover, adaptation
- Service definition & creation

Optimised performance

- Data analytics & capacity planning
- Resource simulation & modelling
- GEO/MEO interoperability

Future-proof extensibility

- Application & service orchestration interfaces
- · Flexible agile software development platform
- Industry leading technology partner Kythera



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O3b mPOWER

What it takes to deliver fibre-like services anywhere

- A Dynamic low-latency high-throughput connections
- Resilient, secure networking in the sky & on the ground
- Adaptive software with open network transparency
- Seamless open network integration

Let us show you how





O3b mPOWER for All Domains

Any beam to any beam connectivity

carriers in bandwidths as small as 15

allows for full flexibility in routing of

MHz to as wide as 2500 MHz



UAV provides multiple links direct to ground/air forces as well as out-of-theater GW.

> 30 30 15 300 MHz MHz MHz MHz GW Hub Land Sea

450	450	300
MHz	MHz	MHz
Sea	Land	Air

SES Gateway		
(7.3m)	Government Hub (4.5m)	45
450 MHz	45 45 30	MHz
GW UAV	MHz MHz MHz	Hub Sea
▲ Ground forces receive 30	Sea Sea Air	Naval forces communicate
MHz of UAV data, as well as	Dedicated in-theatre	directly, as well as to in/out-of-
a 450 MHz commercial out-	government Hub.	theater hubs/GWs.



450	45	45	15		
MHz	MHz	MHz	MHz		
GW	Hub	Sea	Air		

Land Capability



Dedicated in-theatre government Hub.



MHz MHz MHz Land Land Land

SES Gateway (7.3m)



2m class terminal providing 5:4.1 Gbps (2500 MHz) of FWD:RTN to/from an SES Gateway, as well as 50 MHz to an in-theatre hub.

2500

MHz

GW

50

MHz

Hub

0.3m class terminal providing 40:60 Mbps (50 MHz) of FWD:RTN to/from an in-theatre hub.

30

MHz

Hub



1m class terminal providing 80:175 Mbps (50 MHz) of FWD:RTN to/from an in-theatre hub.

Maritime Capability



Ability to support massive forward throughputs using the full Ka-Band spectrum (dual polarization) with up to:

- 10:8.2 Gbps FWD:RTN to a 2m class similar to the CBSP FLV
- 6:3 Gbps FWD:RTN to a 1m class similar to the CBSP ULV



0.6m class terminal providing 200:150 Mbps (500 MHz) FWD:RTN to/from an SES GW and 80:100 Mbps FWD:RTN within the carrier group

GW

2500 500 500 MHz MHz MHz

500 250 MHz MHz GW Sea

1m class terminal providing 600:600 Mbps (500 MHz) FWD:RTN to/from an SES GW and 300:500 Mbps (250 SES PrMHz)*FWD:RTN within the carrier group 2500
MHz250
MHzGWSea

 500
 100

 MHz
 MHz

 GW
 Sea

2m class terminal providing 5:4.1 Gbps (2500 MHz) of FWD:RTN to/from an SES Gateway, as well as connectivity to terminals within the carrier group.

100

MHz

Sea

Aero Mobility Coverage/Capability



Multiple coverage scenarios possible with mPower flexibility/capability:

- Fixed Beam: Single (or multiple) beams traffic locations or where terminal location is unknown.
- A Honeycomb: Multiple beams laid out in a grid pattern over a large theatre, BW and power can be dynamically adjusted
- Follow-Beam: for terminals where performance is a driver could be covered with a dedicated beam globally (+/- 50° latitude)





Follow-Beam

Up to **300 Mbps** of return capacity per terminal with 52 dBW of terminal EIRP (0.6m + 10W) with support of >120 terminals per satellite.



Fixed-Beam

Honeycomb

Up to **80 Mbps** of return capacity per terminal with 46 dBW of terminal EIRP (0.3m + 10W) with support of >240 terminals per satellite.

Encryption Over Medium Earth Satellite (MEO) Network

- Validated and characterized the performance of U.S.
 Government High Grade cryptographic solutions over O3b
- ▲ High Assurance Internet Protocol Encryptor (HAIPE)
- ▲ All encryption testing used the HAIPE v4.1 compliant devices
- Also conducted with VPN wrap around HAIPE devices
- Network jitter never exceeded 2ms during any phase of testing
- ▲ Total latency was not observed in excess of 142ms
- These network characteristics are not only ideal for the application of HAIPE devices
- ▲ Should be found acceptable to nearly any user's application.
- ▲ All encryption devices worked over the O3b system







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ses[^] Networks

Inclined Strategy for Global Coverage

Building on the mPower Architecture

- SES is exploring various orbital and architectural configurations for an inclined solution
- ▲ Current direction is to leverage MEO equatorial, GEO and MEO inclined in a combined solution to maximize performance and coverage, in addition to overall elevation angles.



SE!

Hybrid solution allows each asset to use its strengths

Next Generation Ka-band

Network with Global Coverage



SE:

A seamless, global Ka-band network through dynamic resource management of an all digital architecture

Next Generation Ka-band

Network with Global Coverage

- ▲ Scalable architecture allows:
 - Global Coverage with the fewest deployments
 - mPOWER + 3 GEO's + single plane of 5 (or more) satellites in MEOi
 - Increased efficiency with additional launches
 - 2nd MEOi plane improves elevation angle
 - Allows all MEOi satellites to be used at low latitudes





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UNMANNED AIRBORNE MISSIONS

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Defence & Security Intelligence, Surveillance & Reconnaissance (ISR)



SES

SES is building a catalog of offerings and experience to meet these critical communications challenges for governments worldwide Tier II+ (Group 5) Tier II (Group 4) High Altitude Long Endurance Medium Altitude Long Endurance (MALE) (HALE) Tier II (Group 4) Medium Altitude NATO Global Hawk:SES Predator XP:SES is **Optionally Piloted** Long Endurance is supporting the working with the one of the SATCOM-enabled Persistent - NEW implementation phase of first countries to receive ISR aircraft Surveillance the Global Hawk program New European UAV: the XP in the Middle East Aerostat-based for NATO as well as in the MASI: SES is working to SES is working to HTS SATCOM Suite:SES sensing Initial design and develop an institutional demonstrate the is collaborating on the next development of the system service in conjunction Tactical Persistent capability of a new type generation SATCOM suite with industrial partners Surveillance (TPS):SES of Ku/Ka antenna on a on board select UAVs to to SATCOMenable brand new UAV platform has developed a U.S. Global Hawk:SES ensure HTS capability capabilities such as sea developed in Europe and SATCOMenabled GS supports U.S. Global border surveillance. recently exported to surveillance and Predator/MQ9 Reaper: Hawk training and traffic monitoring and communications capability aovernments in the SES supports the research missions in the piracy from these Netherlands Reaper region and in the Middle via aerostat - portable in Americas optionally-piloted aircraft tow with 1.000 ft. tether. East. program as well as the US Ideal for security and first responders

DISASTER RECOVERY

Disaster

2017 Puerto Rico



www.vox.com

100 days and still blackout in Puerto Rico. What is going on?

SES Networks Works with Project Loon to Restore Connectivity in Puerto Rico

Written on 23 Oct 2017

The combination of SES Networks' innovative satellite-enabled networks, X's high-altitude balloons and local telecommunications expertise is restoring cell connectivity to hurricane-stricken Puerto Rico

Luxembourg, 23 October 2017 – SES Networks' high throughput and fibre-like

y service, the stratospheric balloons operated by X, Alphabet's nshot factory", and local telecommunications expertise are restoring 4G/LTE connectivity in disaster-affected Puerto Rico,

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ENGINEERING

Puerto Rico Looks to Alphabet's X Project Loon Balloons to Restore Cell Service

With much of the U.S. commonwealth's cellular service and electrical grid down since Hurricane Maria, the parent company of tech giant Google could help restore wireless communication to 3.4 million residents

By Larry Greenemeier on October 13, 201

Google's parent company Alphabet is helping bring cell and internet

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HUMANITARIAN AID

TITLE

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SES Proprietary and Confidential

An African Experience





SES Networks provides the UN with end-to-end Managed Services

UN Missions with service:

- MONUSCO (Dem. Republic of the Congo) – Kinshasa and Goma
- UNMISS (South Sudan) Juba and Wau
- UNISFA (Abyei) Abyei
- MINUSMA (Central African Republic) – Bangui
- UNSOS Mogadishu



- SES is fully funded and is launching the next generation of HTS, MEO Satellites, mPower
- SES is the Only Commercial Operator with a proven MEO Constellation and GEO Constellation, Today
- ▲ SES is Ready
John B. Munoz Atkinson

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Connect with us

