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ANALYTICS

Using AI to Optimise HTS and VHTS Ground Network Design and Operations

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What do we do?

Atheras Analytics uses Artificial Intelligence to design and operate networks of ground stations/gateways for HTS and VHTS systems

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Challenge and Solution

- Next generation High Throughput Satellite (HTS) networks can deliver more than 20x the data capacity of traditional satellites at a fraction of the cost per bit
- However, the Ka-band and Q/V-band radio frequencies used by these HTS networks are sensitive to significant atmospheric impairments, primarily from rain
- And many more ground stations/gateways are needed to support the increased data rates/capacity

Atheras Analytics has developed a portfolio of AI-based, SaaS-delivered products that predict, manage and mitigate the impact of weather-related satellite link outages in HTS satellite systems employing Ka-band and Q/V-band frequencies to reduce infrastructure costs and maximise network availability

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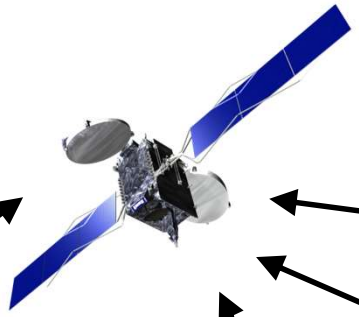
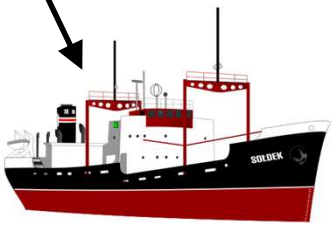
Ka-band Network



Feeder/Gateway Link
Ka-band or Q/V-band

User Links
Ka-band

Gateway



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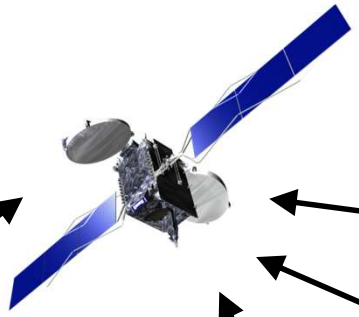
Ka-band Network

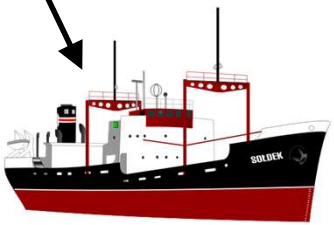


User Links
Ka-band

Feeder/Gateway Link
Ka-band or Q/V-band

Gateway

Rain on a user-link will deprive a single user of service



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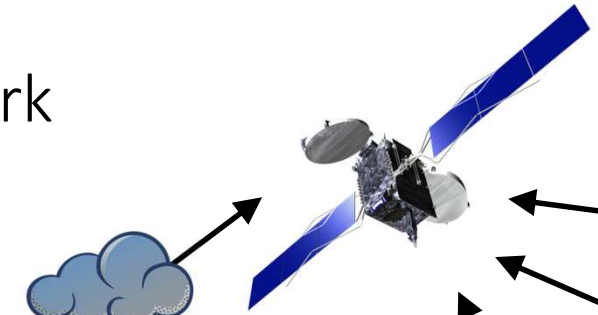
Ka-band Network

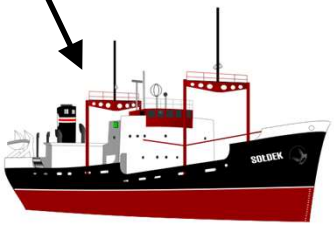
Rain on a feeder-link will deprive all users of service



Gateway

Feeder/Gateway Link
Ka-band or Q/V-band

User Links
Ka-band



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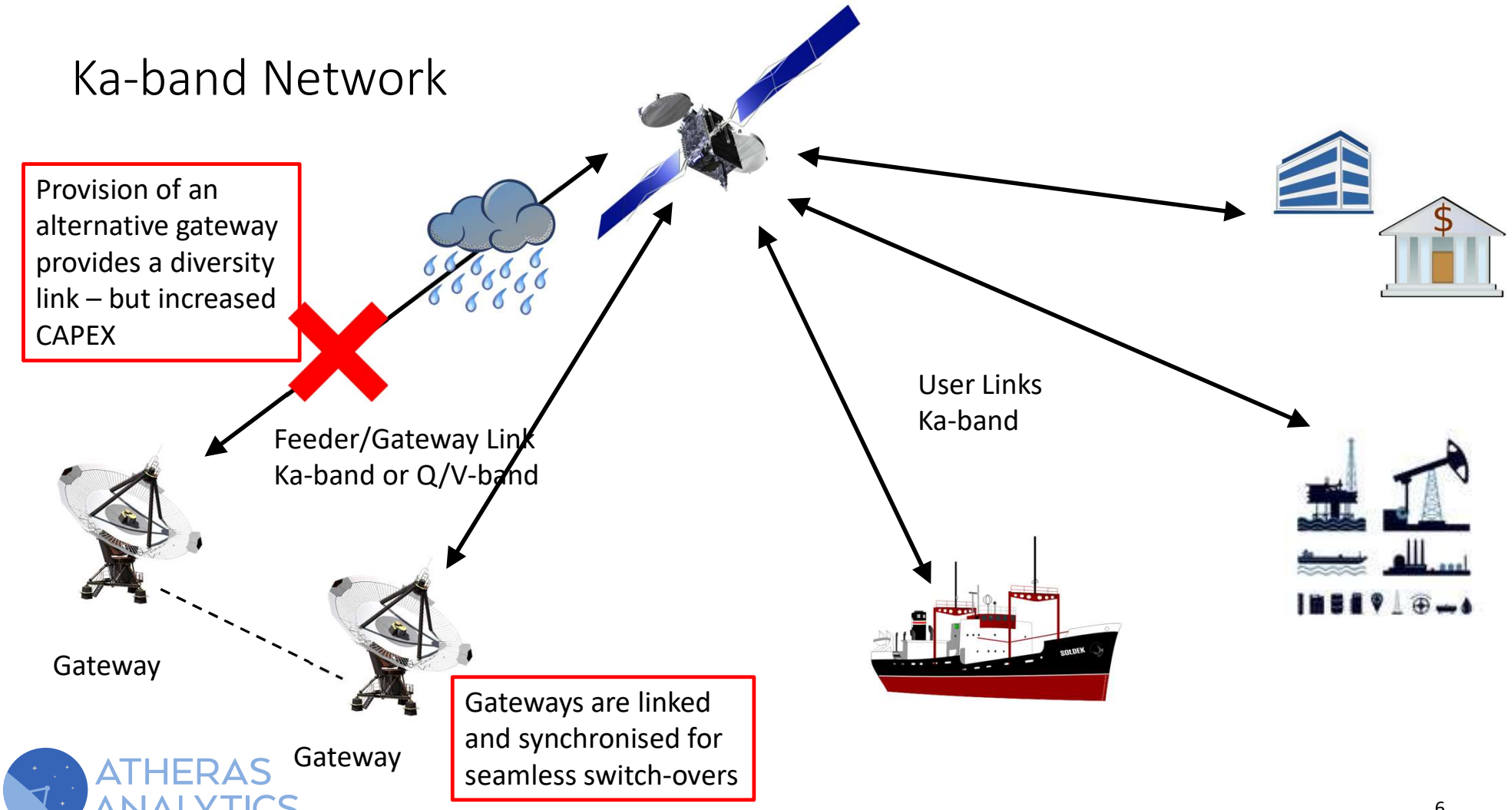
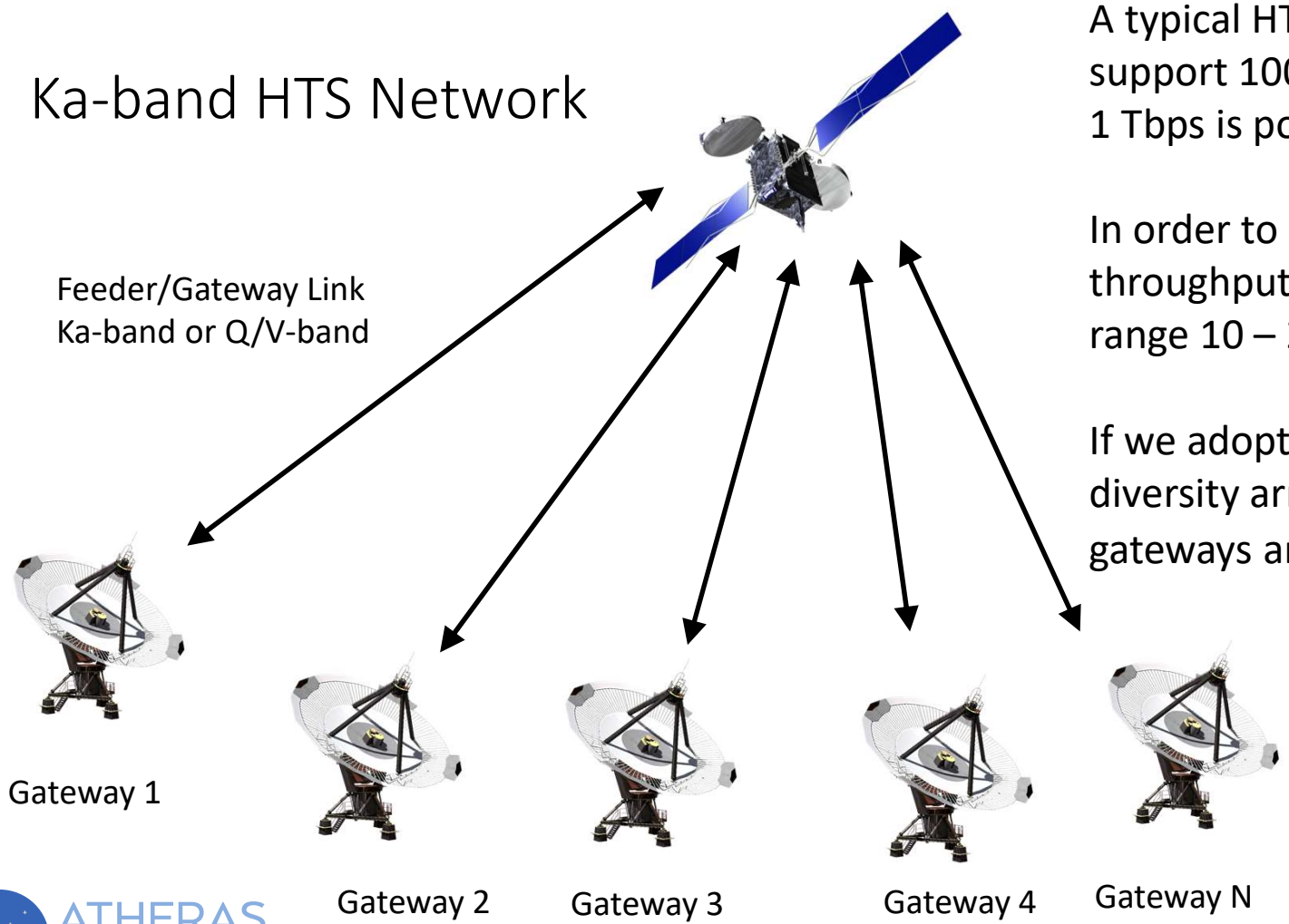
Ka-band Network



Ka-band HTS Network



A typical HTS/VHTS satellite can support 100's Gbps of data.
1 Tbps is possible!

In order to support these throughputs, N needs to be in the range 10 – 200+

If we adopt a conventional 1:1 diversity arrangement, P standby gateways are needed where P=N

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Smart Gateway Diversity (SGD)

- Smart Gateway Diversity (SGD) assumes that not all gateways will be simultaneously impaired by rain and therefore a smaller number of diversity (P) gateways can be “shared” between the active (N) gateways
- However it is no longer possible to keep gateways permanently synchronised as we don’t know which standby gateway will be allocated to which active gateway until the need occurs.
- Gateway synchronisation can take 5-15 minutes so reactive switching will create outages
- How can we benefit from the cost–savings of implementing Smart Gateway Diversity without reducing QoS?

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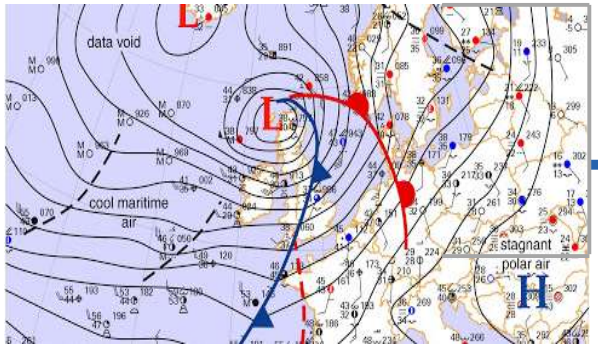
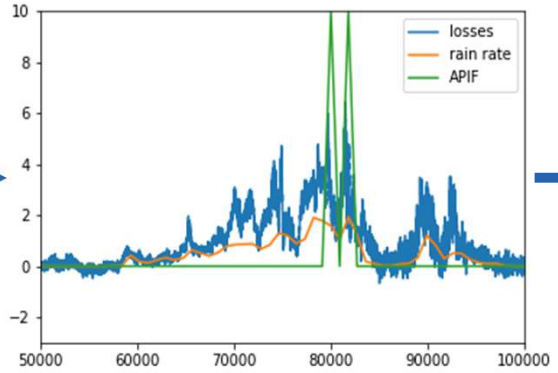
AI-based Outage Prediction Algorithm (OPA) – the core of our software tools





High resolution weather data

Applied to AI-based OPA

Event Predictions

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Design Tool

- The Design Tool applies historic weather data to the OPA for all candidate gateway locations to determine the historic link availability for each gateway
- Atheras Analytics uses last five years of actual weather data, so climate change effects are fully taken into account
- Legacy analytical techniques use long-term statistical data which does not take into account recent climate change effects

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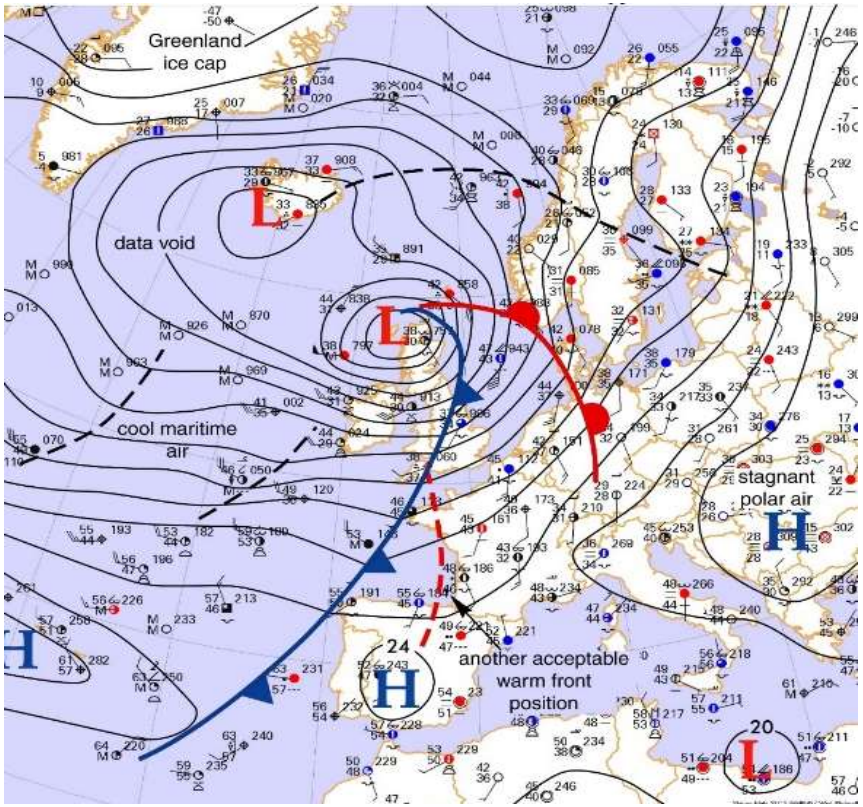
SGD Design Tool

Applying the OPA to multiple gateway locations across a region permits a satellite operator to

- analyse each candidate gateway site for historic link availability
- determine weather correlations between individual candidate sites and
- determine overall network availability for specific groups of gateway locations
- 30%-40% reduction in CAPEX and OPEX for satellite operators with no reduction in QoS



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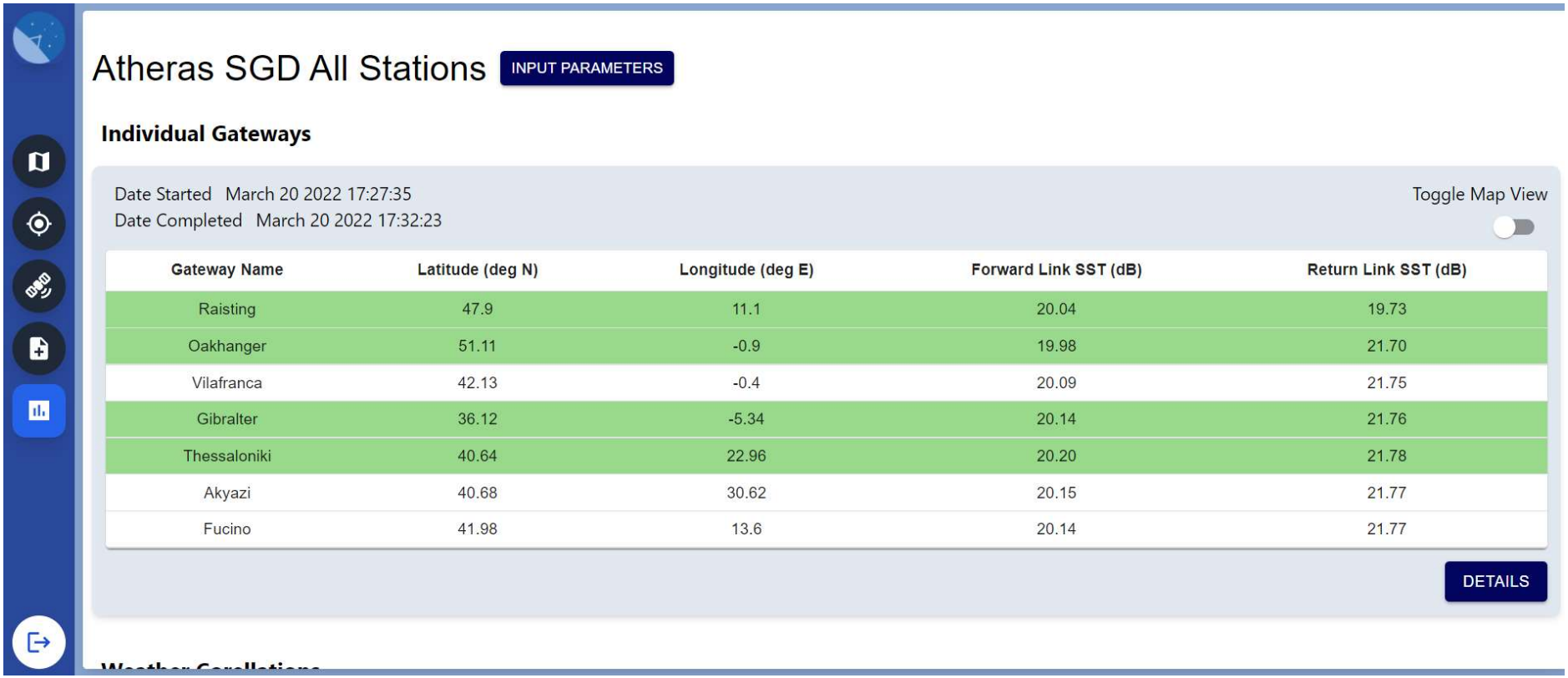
Design Tool – Example top-level inputs



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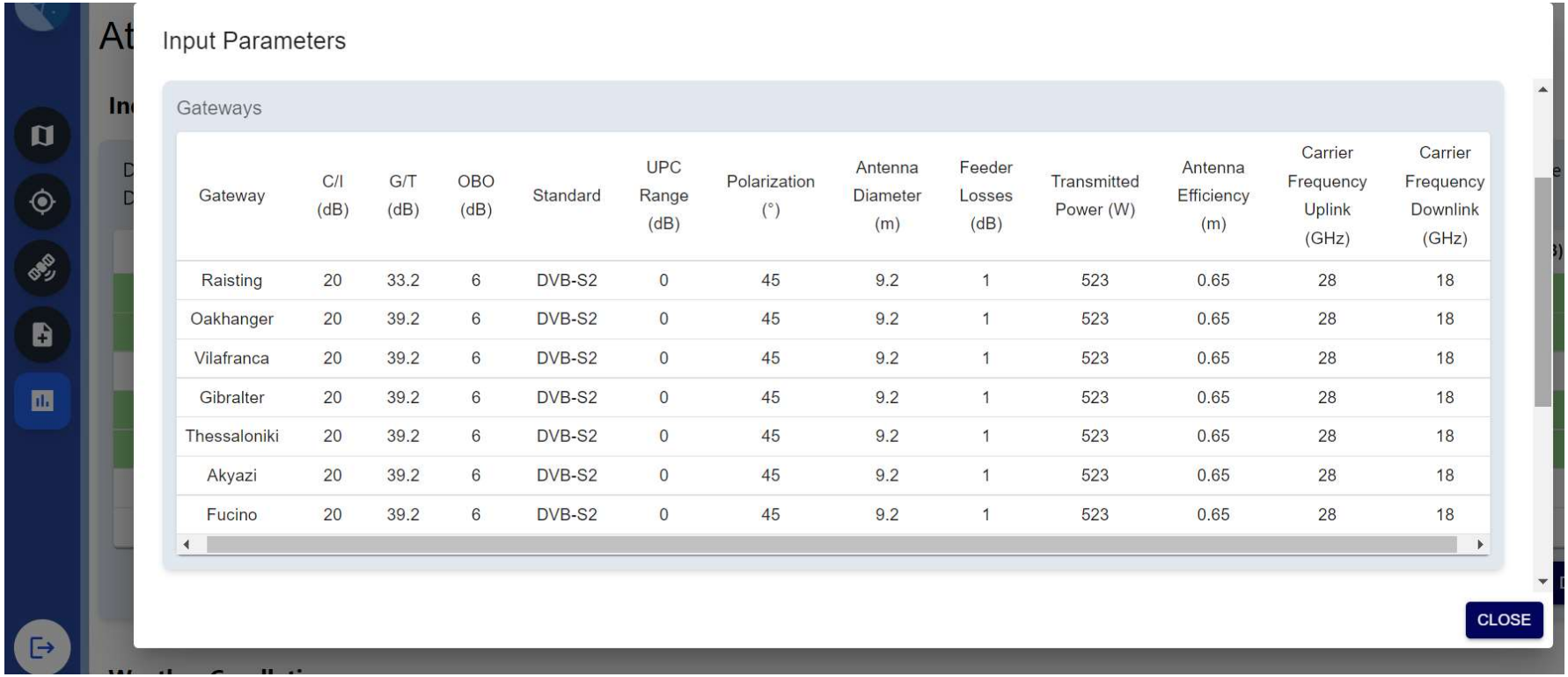
Design Tool – Example detailed inputs



Gateway	C/I (dB)	G/T (dB)	OBO (dB)	Standard	UPC Range (dB)	Polarization (°)	Antenna Diameter (m)	Feeder Losses (dB)	Transmitted Power (W)	Antenna Efficiency (m)	Carrier Frequency Uplink (GHz)	Carrier Frequency Downlink (GHz)
Raisting	20	33.2	6	DVB-S2	0	45	9.2	1	523	0.65	28	18
Oakhanger	20	39.2	6	DVB-S2	0	45	9.2	1	523	0.65	28	18
Vilafranca	20	39.2	6	DVB-S2	0	45	9.2	1	523	0.65	28	18
Gibralter	20	39.2	6	DVB-S2	0	45	9.2	1	523	0.65	28	18
Thessaloniki	20	39.2	6	DVB-S2	0	45	9.2	1	523	0.65	28	18
Akyazi	20	39.2	6	DVB-S2	0	45	9.2	1	523	0.65	28	18
Fucino	20	39.2	6	DVB-S2	0	45	9.2	1	523	0.65	28	18

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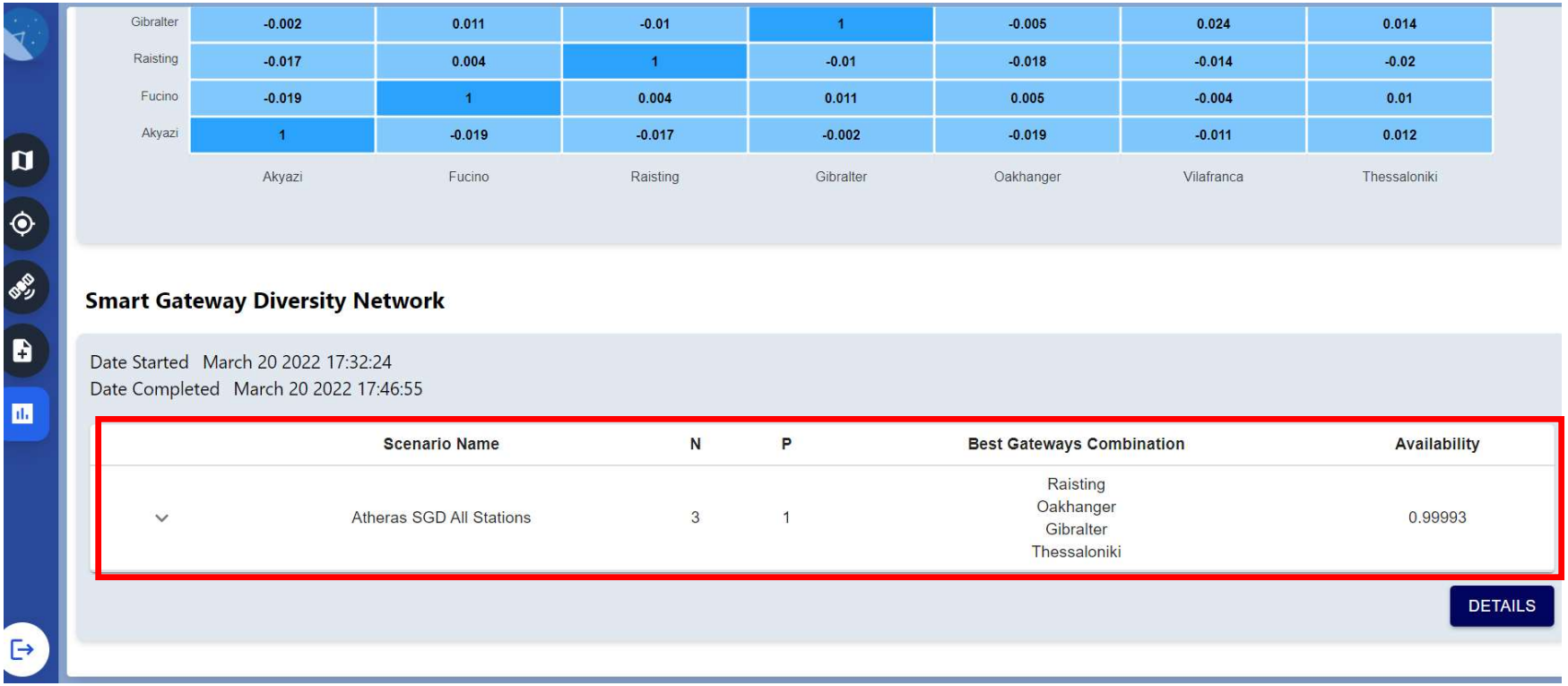
Design Tool – Example output



	Akyazi	Fucino	Raisting	Gibralter	Oakhanger	Vilafranca	Thessaloniki
Gibralter	-0.002	0.011	-0.01	1	-0.005	0.024	0.014
Raisting	-0.017	0.004	1	-0.01	-0.018	-0.014	-0.02
Fucino	-0.019	1	0.004	0.011	0.005	-0.004	0.01
Akyazi	1	-0.019	-0.017	-0.002	-0.019	-0.011	0.012

Smart Gateway Diversity Network

Date Started March 20 2022 17:32:24
Date Completed March 20 2022 17:46:55

	Scenario Name	N	P	Best Gateways Combination	Availability
⌄	Atheras SGD All Stations	3	1	Raisting Oakhanger Gibralter Thessaloniki	0.99993

DETAILS

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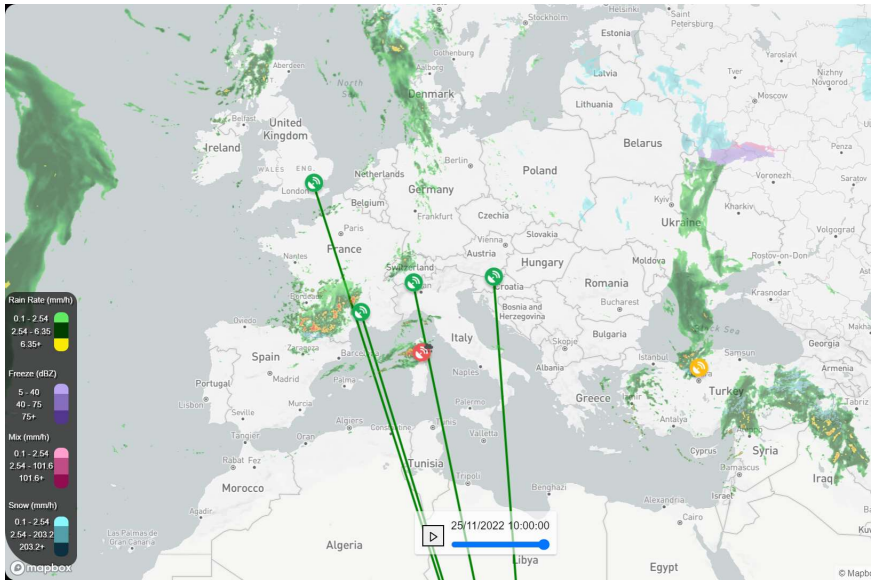
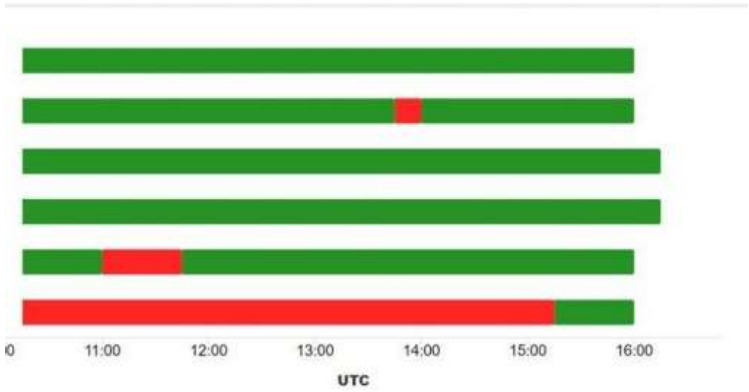
SGD Operational Tool

- Weather forecasts are applied to the OPA
- The OPA is used to predict weather-related outages at individual satellite ground stations/gateways up to 6 hours in advance
- Traffic is transferred to unaffected gateways before the outage occurs
- Network availability is significantly improved





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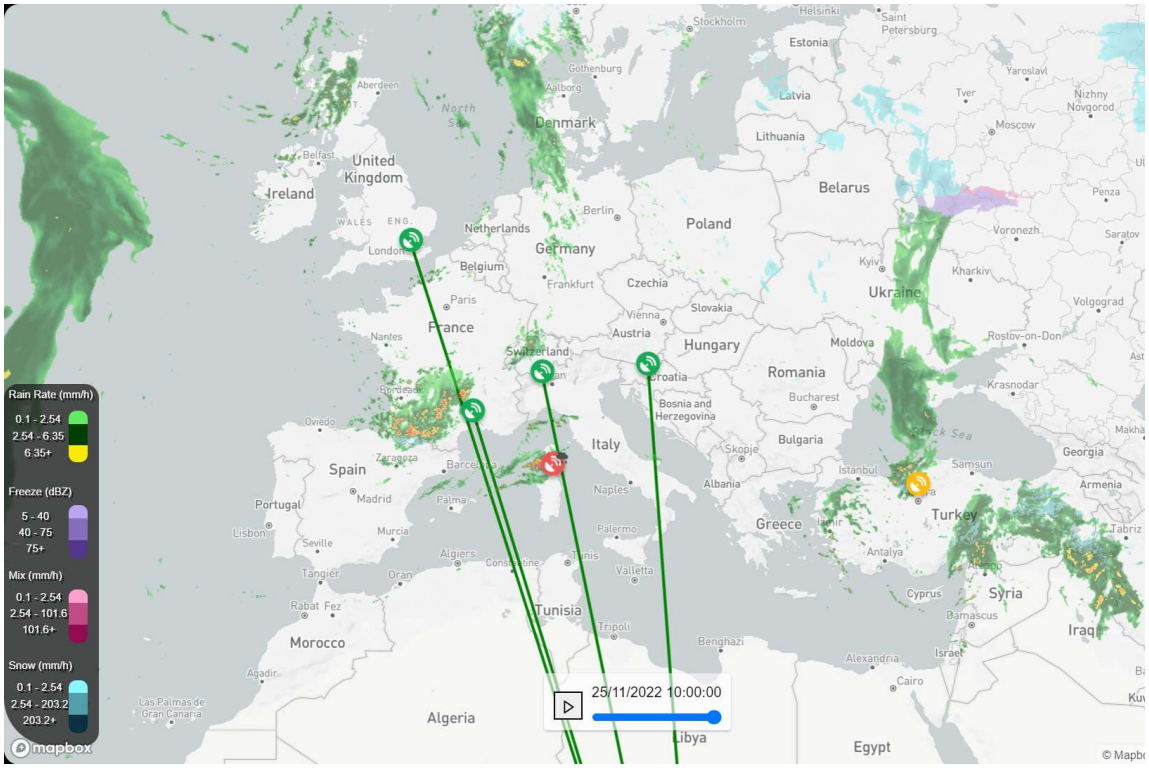
Operational Tool – Network Overview Example



- Five gateways available
- Four active links
- One gateway (red) in outage and unavailable
- One gateway (amber) about to go into outage within the hour
- Reducing service outages by 45% and hence improving Quality of Service (QoS) for satellite operators and end-users alike
- De-icing, sand-storm and high wind warnings also available

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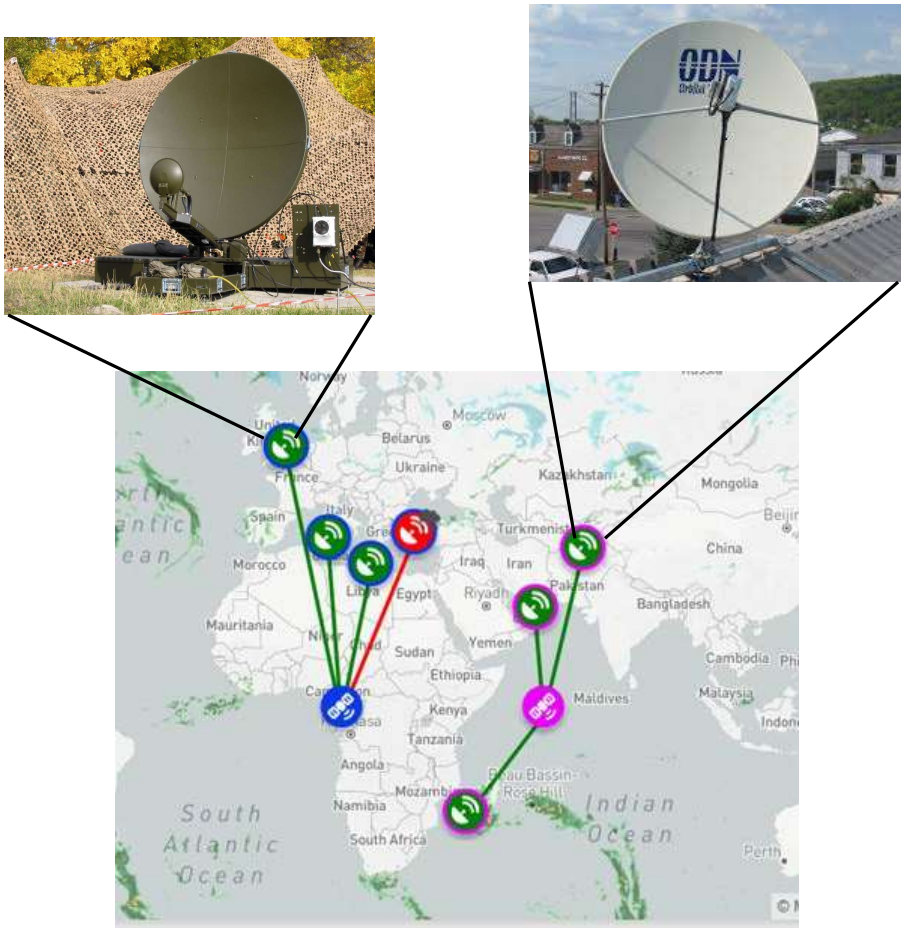
UTOPiA - User Terminal Outage Prediction Algorithm -

- End-users typically employ mobile, transportable or fixed systems with 1-2 metre antennas
- UTOPiA predicts link outages for end-users enabling 10,000's of mission-critical users to pre-empt a satellite link loss and mitigate the operational impact
- User trials successfully completed - evaluation licences are available



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What do we mean by mission critical users?

- Banking – broadband for branches, narrow-band for ATMs
- Social Inclusion – government-backed projects for Universal Service Obligations, rural connectivity, e-governance, education
- Energy – public utilities (electric, water, waste etc), onshore and offshore oil & gas exploration and extraction, mining operations
- Mil/Gov – military applications, civil applications including government, health and environment monitoring
- Others – construction, civil engineering, Air Traffic Management

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