



*Challenge us
to take you further*

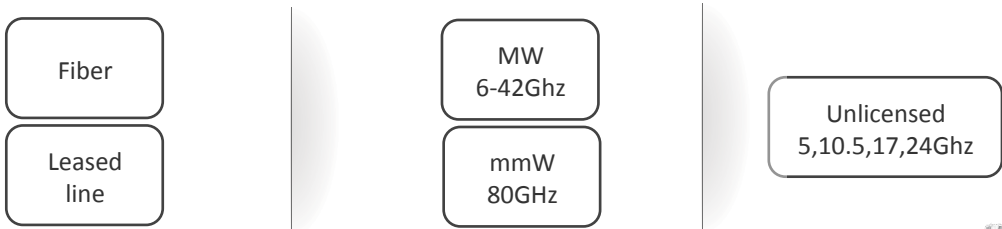
Wireless connectivity trends and solutions for Internet Service Providers

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The Technology Challenge

- Historically – ISP networks were built with a Fibre optic core complimented by license-exempt frequency connections (e.g. 5,10.5,17,24Ghz)
- Today – Many of the unlicensed bands are becoming congested and operationally challenging:
 - Offering limited throughput with unpredictable performance, particularly in urban areas
- A technology evolution is required to deliver future proof connectivity that is:
 - Cost effective
 - Fast to deploy
 - Capable of supporting Superfast gigabit speeds
 - Offers Carrier Class availability
- Wireless technology should be a part of this evolution
- Today's tool box of wireless technologies:



ISP Network Applications in USA and Europe

- Business and domestic internet connectivity
- Rural Broadband connectivity
 - Extend reach / DSLAM backhaul
- Gigabit to the Home
 - Gigabit to the Apartment block
- Gigabit to the Business
- Campus connectivity
 - High capacity building interconnection
- CCTV/Video Surveillance
 - Backhaul CCTV camera traffic to control centers
- Special events
 - Festivals, Concerts
- Disaster recovery - true diversity



Worldwide ISP Wireless Trends - USA

- ISP market is the 2ND largest Ceragon non operator market segment in the USA
 - Continual annual growth and 2015 was the largest year ever for Ceragon in this segment
- ISP market consolidation is happening:
 - Larger ISPs acquiring smaller ones
 - Google fibre recently acquired Web Pass
 - Google fibre now focusing on wireless for access and backhaul
 - 100% fibre business model proved too expensive and too slow
 - Larger ISPs very focused on using wireless for access and backhaul
 - E band – business and residential Gigabit access + High capacity links
 - 11Ghz and 80Ghz – fast growing backhaul frequencies
- Strong transition from unlicensed bands to E band happening in USA
 - Particularly in Urban/City areas
- Gigabit to the home and Gigabit to the business now becoming a reality via E band
- Wireless key in terms of:
 - Time to market
 - Low cost of deployment
 - Quality of service
 - High capacity and reliability





Worldwide ISP Wireless Trends - Europe

- Largest Ceragon non operator market segment with continued strong annual growth
- Strong transition from unlicensed bands to E band happening in Europe
 - Particularly in Urban/City areas
 - E band market growing fast in countries with lower fees:
 - UK = 50 GBP per link per year
 - Unlicensed bands still ok in countryside/rural areas and for residential access
- Gigabit to the business now a reality in UK
 - Gigabit to the business emerging but behind USA
 - Gigabit to apartment blocks + internal cable distribution emerging
- Wireless key in terms of:
 - Time to market
 - Low cost of deployment
 - Quality of service
 - High capacity and reliability
- Key ISP Frequencies:
 - UK: 13,18,23,32,38,60,80Ghz
 - Germany: 18,23,24,38,60,80Ghz
 - Czech Republic: 11,18,26,38,80Ghz
- MIMO technology deployed in the field and ready for future use but in general not used today

What are the connectivity choices for ISPs?



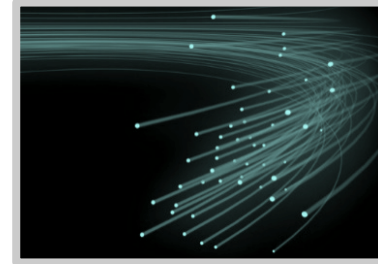
Optical Fiber

Pros

- “Infinite” speed
- Highly reliable

Cons

- Limited availability - its not always where you need it
- Prohibitively expensive to retrospectively to dig and install: \$100-200/m+
- Expensive to lease connectivity from incumbent telco operators
 - E.g. UK = Gig E circuit £10k per annum +
 - Often unknown/unexpected High excess construction charges
- Long lead time times for new deployments
 - Often many months for new fibre to be dug or leased line connections to be connected
- Fibre is the ultimate solution but if its not available what are the alternatives?



Criteria for Fiber alternatives

- ✓ Cost effective equipment cost (CAPEX)
- ✓ Minimal installation lead time and cost
- ✓ Cost effective annual running costs (OPEX)
- ✓ Mature and reliable technology
- ✓ Capacity scalable to gigabit rates



**WIRELESS TICKS
ALL THE BOXES**

The Wireless Toolbox



Wireless backhaul frequency bands

	Frequency	Capacity	Advantages	Disadvantages
LOS/Non LOS	Sub-6,10.5, 17, 24GHz	<200Mbps	<ul style="list-style-type: none"> • Low Cost equipment • Long Distances possible • Weather Resillient • Licence free 	<ul style="list-style-type: none"> • Congested spectrum • High interference inner cities (5Ghz) • Low Capacity (5Ghz)
Microwave	6-42GHz	Up to 4 Gbit	<ul style="list-style-type: none"> • Long distance possible at low frequencies • Low equipment cost • Mature technology 	<ul style="list-style-type: none"> • Congested spectrum • Expensive annual license fee
E-band	71-86GHz	Up to 2.5 Gbit	<ul style="list-style-type: none"> • Up to 2.5Gbit Capacity • Zero license cost • Very uncongested spectrum • Narrow beams allow highly dense networks to be built 	<ul style="list-style-type: none"> • Distance < 5 Km



Unlicensed Bands (5,10.5,17,24Ghz)

- Low equipment cost
 - Point to point and point to Multi point options
 - Residential ISP connectivity
 - Per camera CCTV connectivity
- Unlicensed bands
 - Zero licence cost
- In urban areas a high capacity/high availability link can be challenging
- Many ISPs looking to transition to the next step
 - E band is becoming the next step



Licensed Microwave (6-42Ghz)

- Pros
 - Readily available
 - Inexpensive equipment
 - Gigabit + capacities possible
 - Long distances possible
- Quick and simple installation
 - All outdoor versions mean no indoor space needed
 - SW Wizards enable low cost / lower skilled installers
- Mature and reliable technology
- Deployed massively on a global basis



E-Band (71 -86Ghz)



- Uncongested – newly opened band, More than 10Ghz of spectrum available
- Very wide channels \Rightarrow Multi Gigabit throughputs possible
 - Ceragon IP-20E offers Channel sizes from 62.5Mhz up to 500Mhz
 - 1Gbit in 250 Mhz channel
 - 2.5 Gbit in 500 Mhz channel
- Pencil-beams (beam-width $< 1^\circ$):
 - Minimum interference
 - Secure (hard to detect and intercept)
 - Allows very high levels of co - location
- All outdoor
 - Lower cost and simplified I&C
 - Low power consumption – POE powered
- Band of massive capacity
 - Up to 2.5 Gbit today
 - 10Gbit in the future
- Will be the big band for the future of ISP networks:
 - Offers high capacity, high density network possibilities at Gigabit plus capacities
 - Zero license cost

FibeAir IP-20 platform

A SINGLE platform under a single CERA-OSS serving

ALL your wireless backhaul needs



IP-20V
All-Outdoor

IP-20E
All-Outdoor

IP-20S
All-Outdoor

IP-20G
Split Mount

IP-20C
Multicore

IP-20GX
Extendable

IP-20N/IP-20A
Modular

IP-20LH/IP-20A
Long Haul

V-Band
(future)

E-Band

6 - 42GHz

4 - 11GHz

Public Safety

Wireless ISP's

Utilities

Oil & Gas



Summary

- Hybrid Fibre/Wireless ISP Networks can now be built to offer high capacity and high reliability services
 - E band is emerging as the default wireless band for many ISPs globally
- Fibre enabled points of presence with wireless extensions offers a great model for a high capacity, high availability, low cost network
- Use Ceragon's Wireless IP20 portfolio as your wireless toolbox to build hybrid fibre/wireless networks:
 - 6-42Ghz and E Band options
 - Multi Gigabit over-the-air capacity
 - Carrier-grade performance
 - Fast and easy deployment
 - Quick ROI




Increase your
operational efficiency



Ensure your
peace of mind



Enhance your
customers' quality
of experience



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