



What if life moved at the speed of ideas?

BROADBAND WIRELESS BACKHAUL: Microwave links evolutions to become the solution



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..... Alcatel-Lucent 

**Are you
seeking
short term
solution or a
long term
Success?**

Agenda

Item 1 | Let set the scene of Mobile Broadband

Item 2 | Backhaul the bottleneck for MB deployment

Item 3 | Microwave Packet radio the solution

Item 4 | Optimized Mmwave Packet radio the Enabler

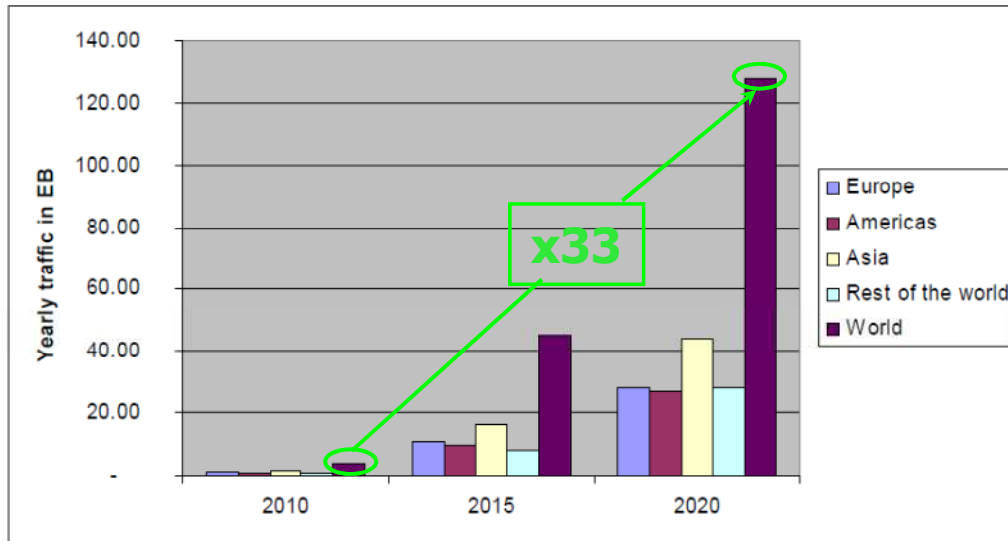
Item 5 | Conclusion

Mobile Broadband

Tremendous increase of the demand

- From UMTS Forum report 44: "Mobile traffic forecasts 2010-2020"

Figure 68: Total mobile traffic (EB per year - World)



Source: IDATE

- Confirmed when looking for representative 50 Millions inhabitants Western European country: in that case the increase on capacity demand is X65 in 2020 compared to today!! (x26 in 2015)

- Traffic increase driven by Dongle, smart phone and video
- Also linked to population density and leisure time
- X33 global increase between 2010 & 2020
- Already X11 in 2015

Table 25: Total mobile traffic per year- Representative Western European Country

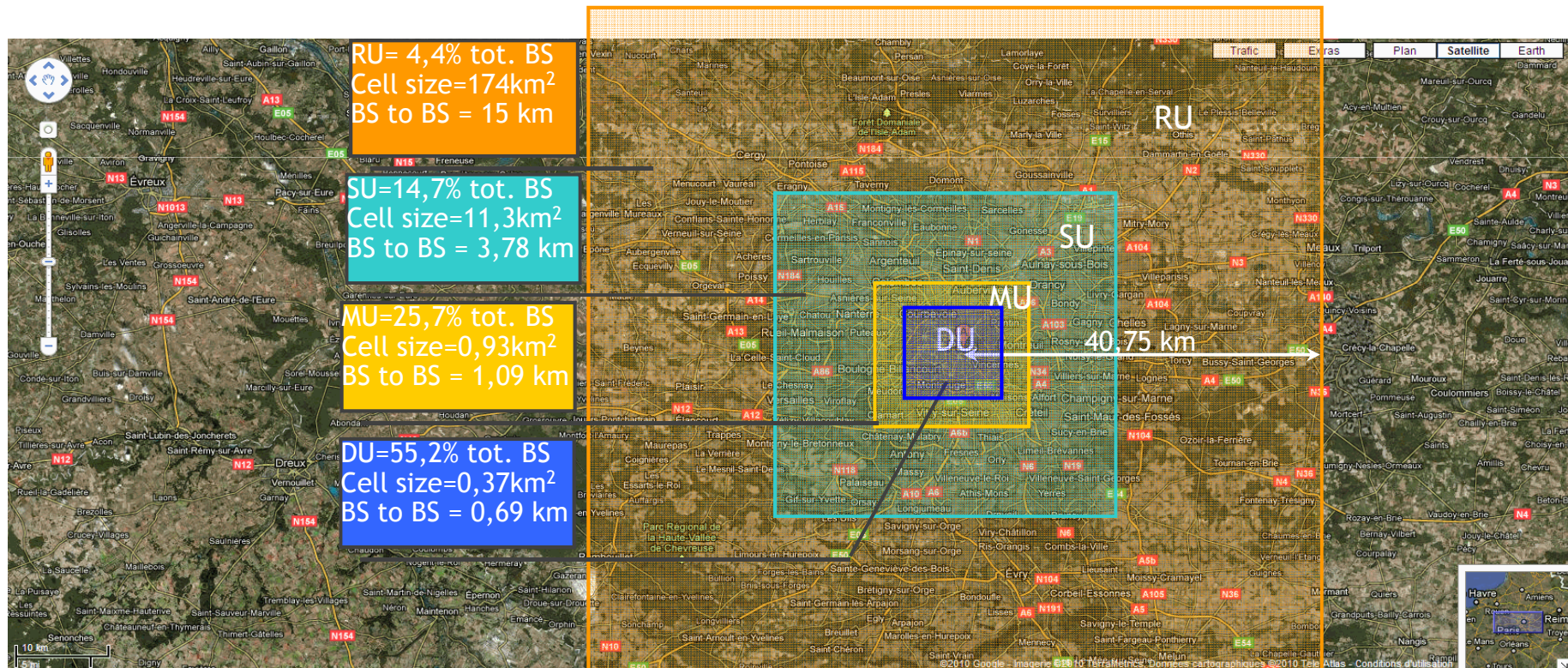
Total mobile traffic	2010	2015	2020
Representative Western European Country (EB per year)	0.07	1.86	4.58
Representative Western European Country (PB per year)	70	1,860	4,580

Source: IDATE

Mobile Broadband

Only a partial answer by the ran technology

- From HSDPA+ to first LTE we will have only a X2 in capacity per BS
 - If we consider that we maintain the both we get a X3 versus what we get today
- For a 2010 theoretical total coverage in HSDPA+ in Paris region:



Mobile Broadband

Only a densification and small cells can answer

- To complete the remaining X4 in 2015 and X 10 in 2020 for the global scenario
- To complete the X9 in 2015 and the X 22 in 2020 at least for a region like Ile de France which is the highest population density region of a representative western European country!
- This means :
 - Much smaller output power ☺ **Better for Health**
 - Much smaller consumption ☺ **Better for sustainability**
 - Much smaller distances between BS (<300 meters 90% of the cases)
 - Better city and indoor coverage ☺ **Better customer satisfaction**
 - Much more backhaul ☹ **Worst for operator investments**
 - backhaul geographical granularity ☹ **Worst for operator deployments**



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Backhaul the bottleneck for MB deployment

What requirements for this backhaul

- If you're thinking long term:
 - Bit rates considered per small BS should be 100 Mbits/s up to 300 Mbits/s
 - Bit rates for Macro/hub BS up to 1 Gbits/s (LTE+HSDPA+ and small cells)
 - Ethernet connection and packet based (Ethernet, MPLS, IP) with packet management features (QoS, Synchronization, OAM, potentially switching or routing) and low latency
 - If possible as the BS, it needs to be POE
 - Easy to install as small BS with same people
 - Low cost
- What are the best candidates:
 - Fiber connection is the best ...when present
 - VDSL (capacity & synchronization issues?) ... When present
 - Wireless "Non Line Of Sight" (PtP and PMP) including WiFi
 - Wireless PtP microwave

Backhaul the bottleneck for MB deployment

Fiber the ultimate solution

- Fiber for sure the most reliable solution:
 - The issue is that the time schedule for fiber deployments for fixe with the needed geographical granularity is generally in delay compared to the one we foresee for Mobile Broadband even in developed countries

- From IDATE research datas and population statistics

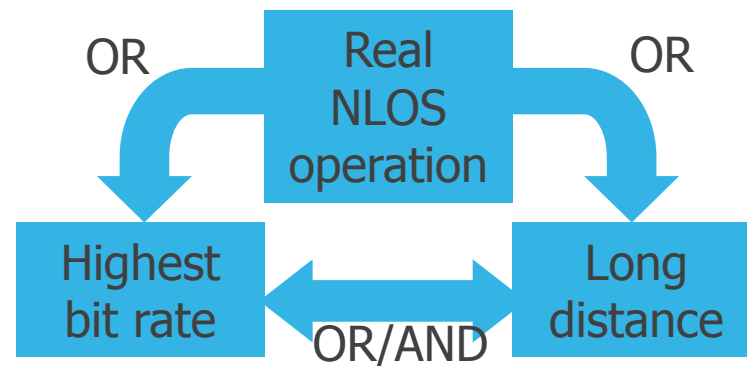
Fibre connections In 2015	Connected homes (000)	Total Homes (000)	Total population (000)
France	13 722	29 318	64 500
USA	28 109	105 000	325 723
Germany	12 409	N.A	81 500
UK	6 117	N.A	62 272

- Despite efforts the deployment time and costs are limiting the fixe deployments
- The same issues limit as well a particular deployment for a base station increasing drastically the TCO and/or time to switch it on. Particularly in urban areas even for distances lower than 100 meters

Backhaul the bottleneck for MB deployment

Wireless "NLOS" (<6 GHz) a good start solution

- The available bandwidths are very limited, crowded and not totally available because of the presence of unwanted signals (Noise of Radars, Industrial spurs, etc...)
- Despite counter measures and advance signal treatment (MIMO) Shannon limits and physics are inflexible: You have to choose!!



- By definition and in conjunction with small bandwidth as soon as real NLOS will be used the number of Backhauled BS per square km will be reduce
- Limited RF bandwidth = limited highest bitrates which means not applicable for all BS
- If Non licensed band are used you cannot completely guaranty the service continuity (QoS and QoE)

Backhaul the bottleneck for MB deployment

Wireless PtP microwave a reliable renewed solution

- The new generations of microwave packet radios are just in line with:
 - Full data usage
 - Increase of capacity (up to 1 GigE)
 - Full outdoor
 - Easy to install and cost effective
 - Full data network capabilities
- LOS is not a real issue due to shorter distances
 - Also passive or active relays can be used
 - A simple, mesh network between the street level BS with only a time to time connection to the Point of Presence (like an Overlay standard BS) when possible solve the issue with a long term perspective thanks to the high capacity
- The new Millimeter wave bands (V and E Band) are particularly dedicated for this urban and sub urban usage.
 - Permitting very High bit rates and small form factors when well used

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Microwave Packet radio the solution

Cost effective and easy to install

- The New generations of Packet microwave radio (Like MPT HC) are able to be used in full outdoor carrying up to 1 Gbits/s Ethernet signal on standard ETSI channels, fixe or adaptive modulation up to 2048 QAM, ATPC and XPIC. All this Powered over Ethernet if needed.
- On the standard bands they can be used for Urban application (15 to 38 GHz) or in rural and long range (6 to 15 GHz) for Macro backhaul
- On Sub 6 and mmWave for the small cells
- On mmWave for very high bit rate short distance low cost
- Carrying & supporting all types of packet protocols over Ethernet physical layer (Ethernet, MPLS, IP...) including synchronization (SynchE, 1588V2, BITS,...)

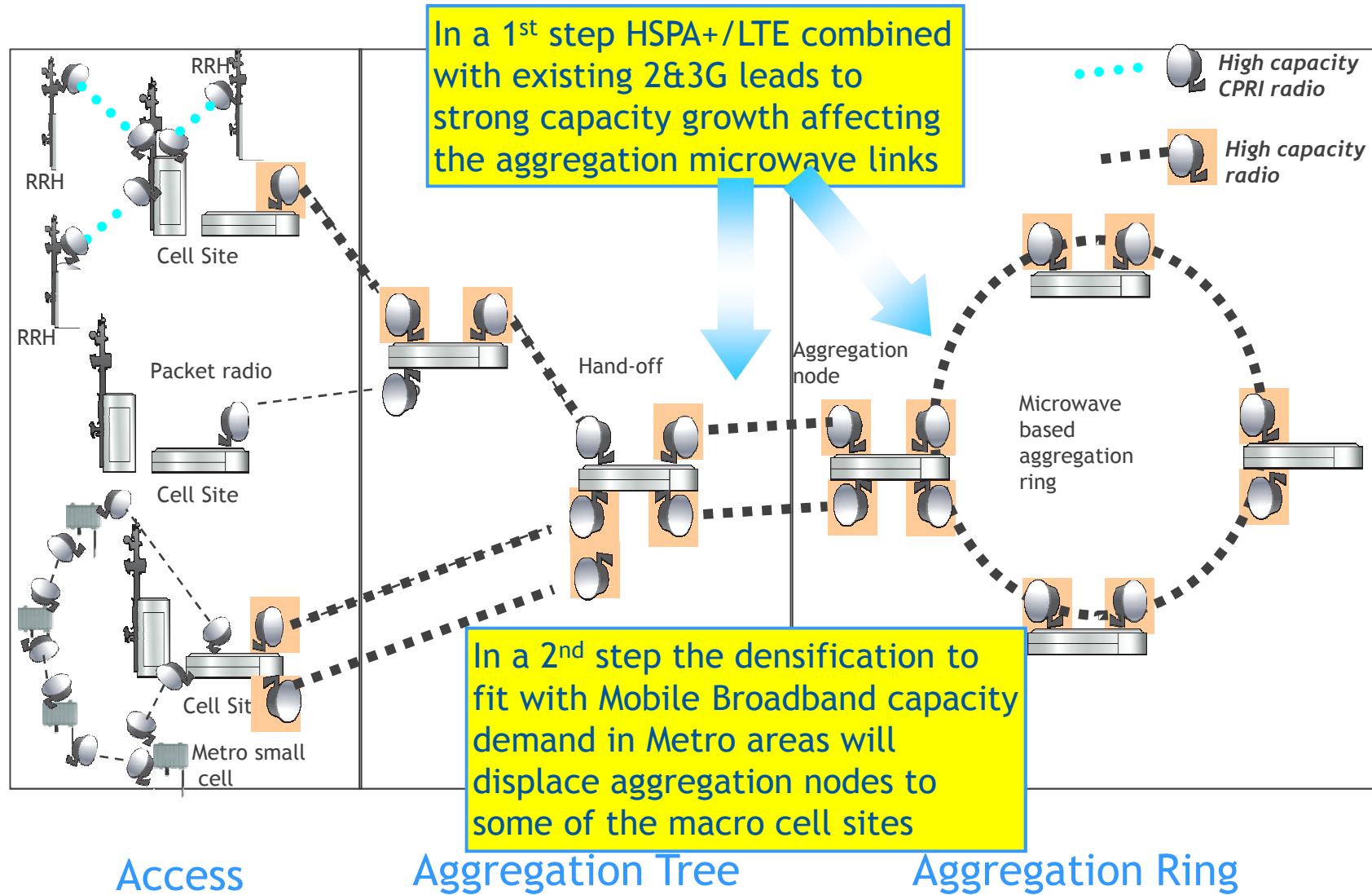


- Associated to the proper Chassis they can even aggregate any type of traffic on Ethernet, get all complex microwave functionalities (hitless 1+1HSB, Frequency diversity, Space diversity) and having network capabilities in case of node.
- Associated to the 7705 SAR-x it becomes also an MPLS access point.

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AT THE SPEED OF IDEAS™

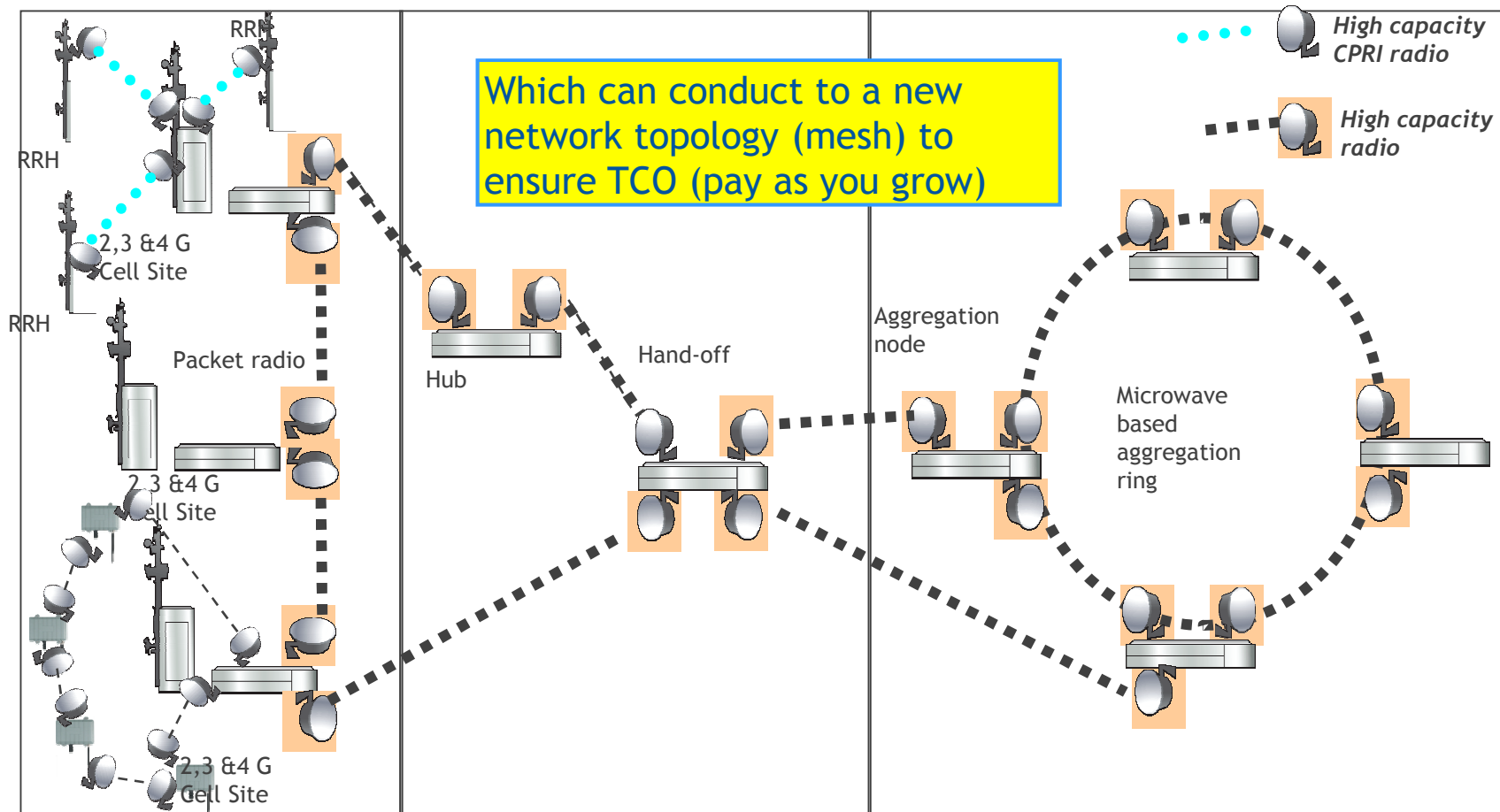
Microwave Packet radio the solution

Complex end to end and pay as you grow



Microwave Packet radio the solution

Complex end to end and pay as you grow



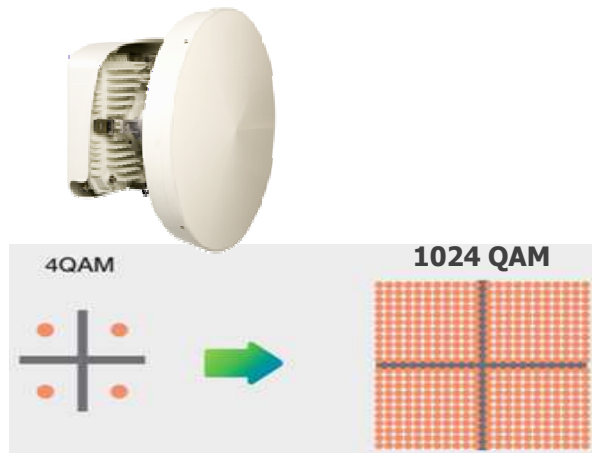
Access

Aggregation Tree

Aggregation Ring

Evolution to highest capacities

modulation and digital enhancement



128 QAM @ 28 MHz:	155 Mbit/sec	
256 QAM @ 28 MHz:	178 Mbit/sec	+15%
512 QAM @ 28 MHz:	199 Mbit/sec	+12%
1024 QAM @ 28MHz:	220 Mbit/sec	+11%

2013 MPT Evolution to support 512, 1024 & 2048 QAM with EMBEDDED XPIC fonction

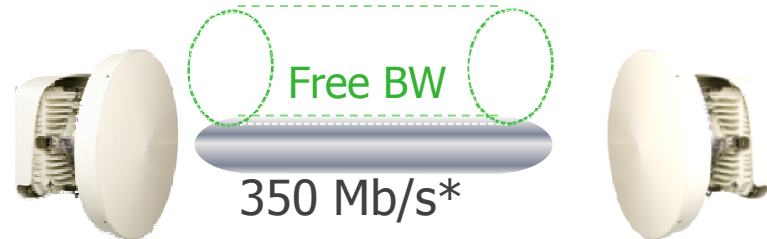
1 Gb/s



Preamble suppression
IP/MPLS/Ethernet header
compression



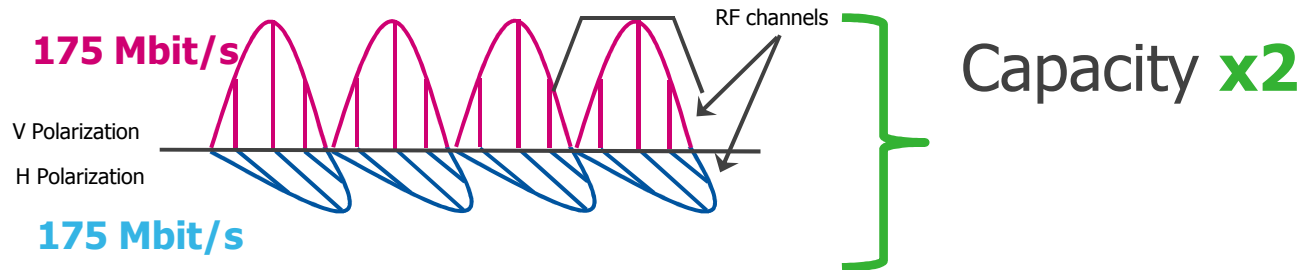
Up to capacity **x3**



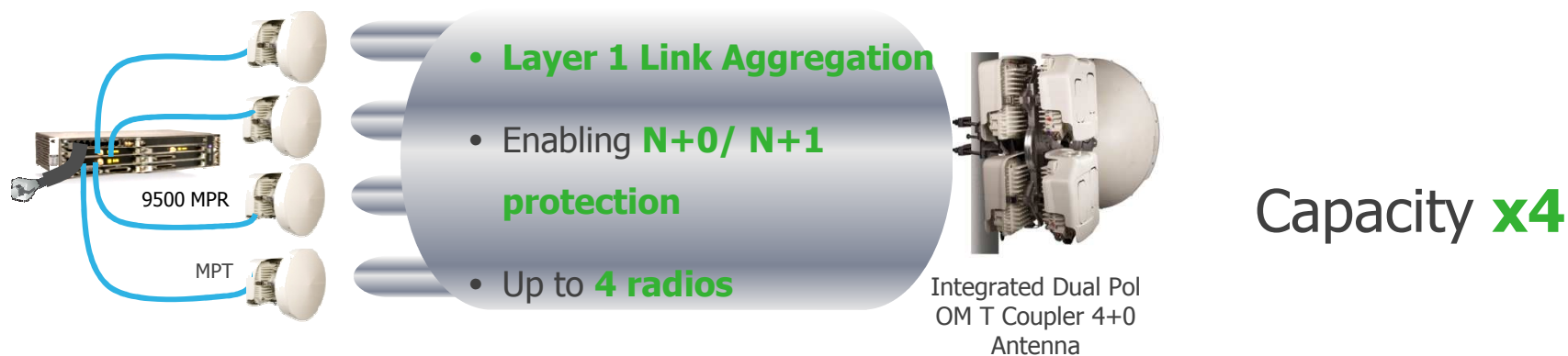
HIGH CAPACITY & AVAILABILITY

XPIC &/or MULTI-CHANNEL LAG L1 N+0

- Using the same channel frequency with two different polarizations on the same antenna doubling the capacity (available on all modulations and channels)



- Using Multi-channel LAG we can split a very high incoming rate into four radio and recover it with full with a flow (L2) or packet by packet management (L1)



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Optimized Mmwave Packet radio the Enabler

MMwaves the physical natural choice

- High available free bandwidth with 10 times larger channels at lower cost
 - Permits very high bit rates with smaller difficulty
 - As free (E-Band) permit to organize with the good well known rules
 - Highest possible cost effective modulation scheme
 - ATPC mandatory
- Small wave length:
 - High directivity antennas with twice less equivalent surface than 38 GHz
 - Small wave guide dimension ease use of flat antennas
 - Compactness of the radio design
- For V-Band high gaseous attenuation permitting the frequency reuse
- E-Band uses the same spectrum rules world wide and permit to backhaul small cells and longer distances BS, and become for those reasons the first choice.

Optimized Mmwave Packet radio the Enabler

Thanks to Bell Labs we know what we can get

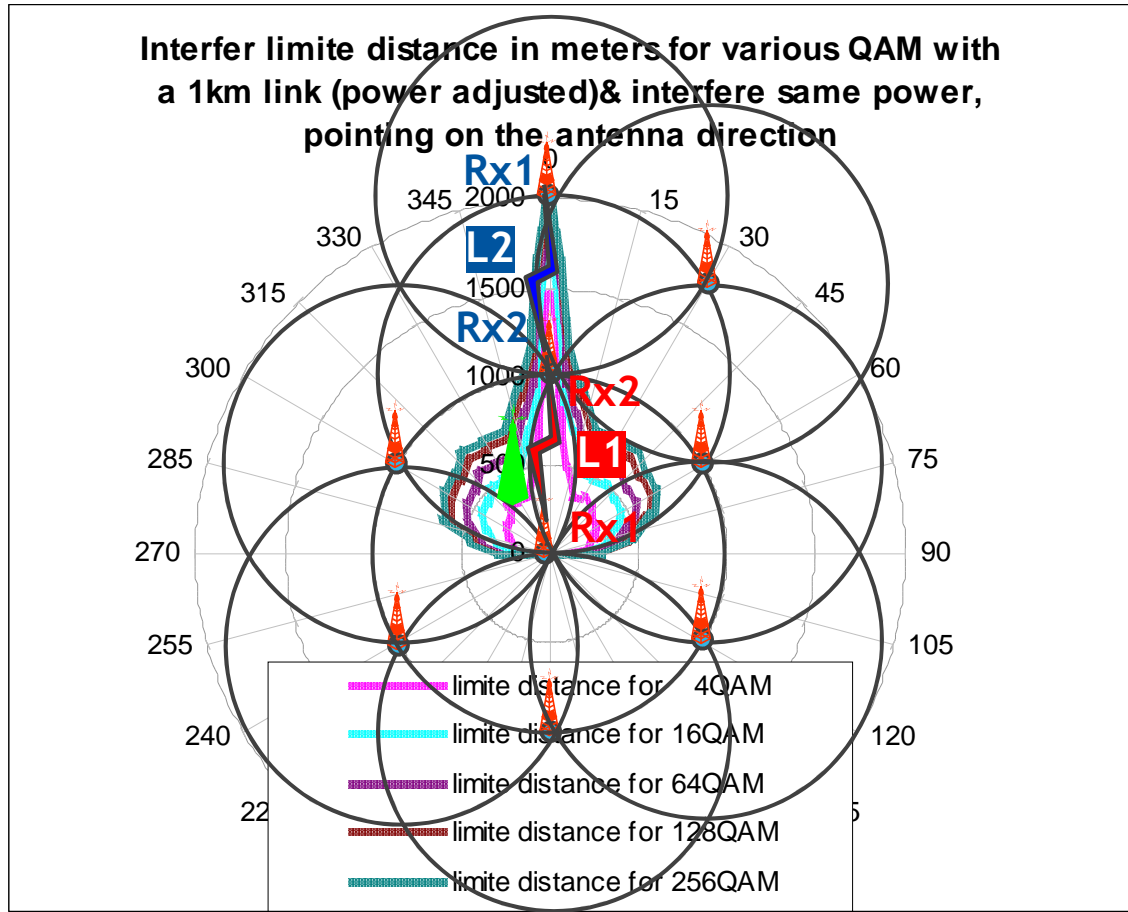
- The actual technologies developed in Bell Labs already permit to ensure that in E-Band we will be able to :
 - Guaranty a 400 m 1 GigE link in 250 MHz world wide (99,999% availability) with :
 - a smaller form factor (10x10x10 cm total) than the actual small cells BS with a 1,5° 3dB beam width antenna
 - A full integrated radio permitting high QAM modulations
 - Only a pair of radio to cover all the frequency band (19x250 MHz Channels)
 - Use of ATPC to enhance frequency reuse
 - A 1,5 km with a 20X20 cm antenna
- Because antenna directivity alone will not protect against interferences and permit long term usage of this solution we need that regulatory bodies take into account all the (bad) experience suffered on previous microwave bands to go directly to the right light licensing solution using directly state of the art technologies

Optimized Mmwave Packet radio the Enabler

The good regulatory choices to guarantee success

- 1 GiGE minimum bit rate per 250 MHz in conjunction with a ATPC will ensure a long term usage of the frequency plan.
- On a 1 km BS to BS distance network which represent a standard actual network in Urban western Europe area or NA considering a 35 mm/h rain fall region, and even using alternate reuse of frequency, this channeling and the complete usage of the frequency plan is the only way to avoid interference issues

Even more if we consider to add any of the new needed BS to face the data traffic expansion



A light licensing is a preferred condition for a plain use of this technology

ALCATEL-LUCENT 9500 MPR-s @ 60GHz

POINT-TO-POINT, LINE OF SIGHT APPLICATIONS



9500 MPR-s (@60GHz)

9500 MPR-s (@ 60 GHz)	FEATURE HIGHLIGHTS
RADIO	<ul style="list-style-type: none"> • FDD System • Data rate up to 1 Gbps full-duplex • Channel Width 160 MHz BPSK/ 170 MHz QPSK/ 550 MHz
ETHERNET	<ul style="list-style-type: none"> • Max Ethernet frame size 10,240 bytes • VLAN Management • QoS
MANAGEMENT	<ul style="list-style-type: none"> • Management interface • Web server (HTTP) • SNMP
PHYSICAL	<ul style="list-style-type: none"> • Integrated flat antenna • Low power consumption (18W) • Temperature range -45°C to +55°C

HIGH CAPACITY, AVAILABILITY, QoS - EASY TO DEPLOY, LOW OPEX

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Conclusion

What are the conditions for a long term success

- You must take care that your investment will take into account the next 5 to 10 years programmed evolution
- Small cell backhaul will become one major bottlenecks for the customers satisfaction
- The best solution when already present is fiber backhaul
- The best complement when fiber not present is microwave Packet radios and new Compacts E-Band radios taking the plain advantage given by physics and Bell Labs new technology developments
- Light World wide licensing is necessary if we want this to become your long term success.



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