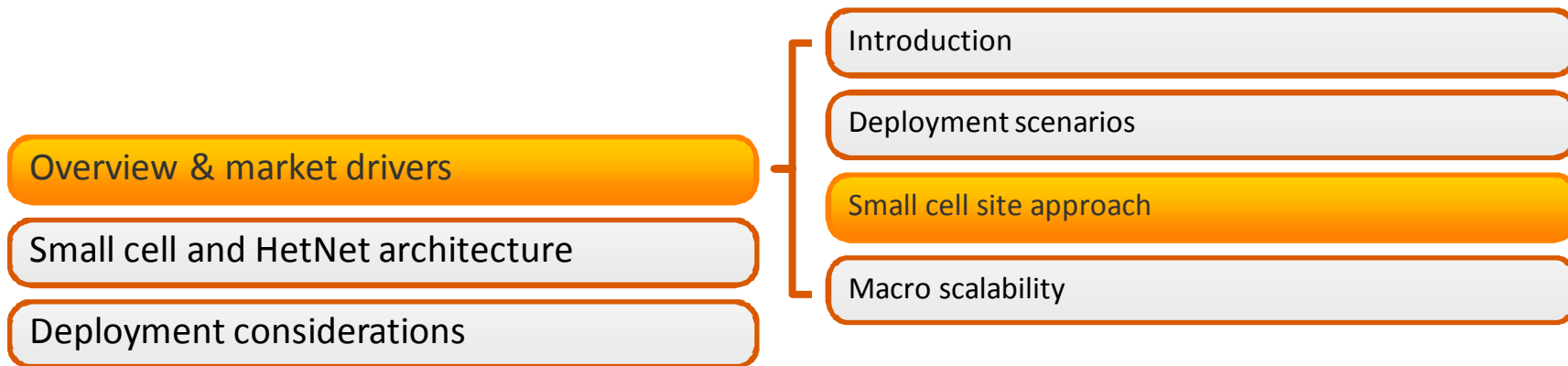


Small cells

Contents



When might a new macro site not be feasible?



- No space for new macro site BTS or antennas.
- New macro site permits not granted or site lease is very expensive
- Site is too far from optimal location



- Cellular tower or pole is not accepted by authority community
- New macro site is overkill



- Macro sites cells capacity is not enough
- More and smaller capacity cells need to be added



- Safety regulations limit the transmitted power at street level











- Smaller cell and low transmit power is optimized for e.g. indoor usage, tunnels and parking lots



- New macro site is overkill (cost, capacity, size) for coverage fix or extension

Small cell site examples

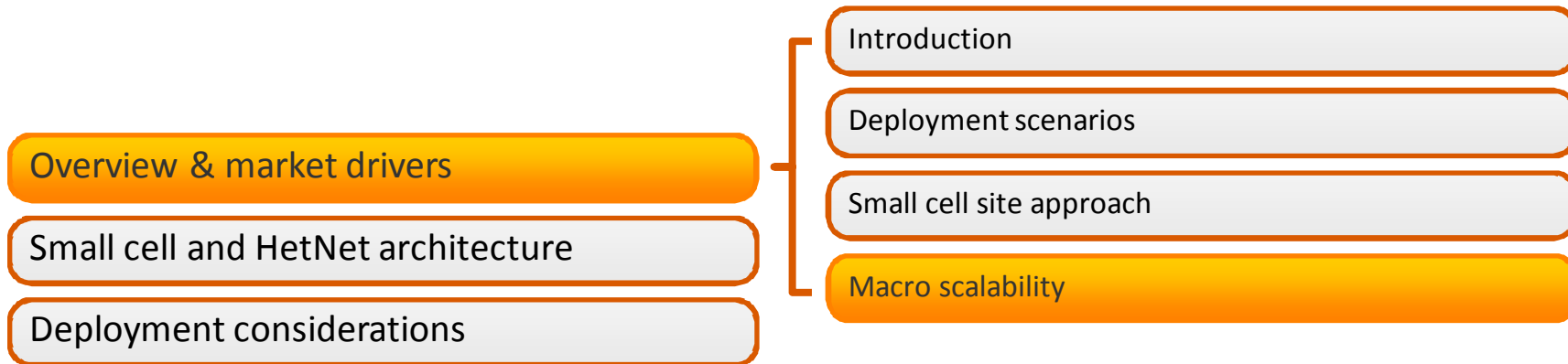
Small cell site examples

 <p>Indoor enterprises</p>	 <p>Indoor public spaces</p>	 <p>Utility poles</p>	 <p>Lamp posts</p>
 <p>Residential homes</p>	 <p>Outdoor building walls & rooftops</p>	 <p>Strands</p>	 <p>Bus stops</p>

Key small cell cost items are site and backhaul

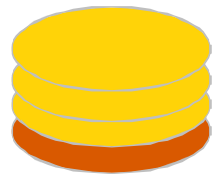
Small cells

Contents



Example European operator single macro site capacity limits

High capacity HSPA macro site



- 15 MHz @ 2100 MHz band
- 5 MHz @ 900 MHz band
- **Total 4 HSPA carriers**



- Average HSPA cell throughput 6 Mbps
- 3 sector site with 72 Mbps throughput
- 6-sector site with 50% gain provides 108 Mbps (up to 80% gain possible)
- Additional 20 - 30% gain with DC/MIMO

High capacity HSPA+LTE macro site



- LTE 20 MHz @ 2600 MHz band
- HSPA 15 MHz @ 2100 MHz band
- LTE 10 MHz @ 1800 MHz band
- HSPA 5 MHz @ 900 MHz band
- LTE 10 MHz @ 800 MHz band
- **Total 4 carriers HSPA + 40MHz FDD LTE spectrum**

- Average LTE cell throughput 35 Mbps (20 MHz)
- 3 sector site with 282 Mbps throughput
- 6-sector site with 50% gain provides 423 Mbps (up to 80% gain possible)
- Additional 20 - 30% gain for HSPA with DC/MIMO

Radio capacity and coverage for growing online consumption

Additional carriers and new bands

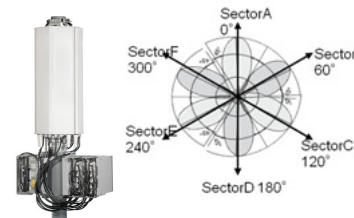
- Typical near future European operator scenario for MBB spectrum usage

2600 MHz	LTE 20 MHz
2100 MHz	HSPA 15 MHz
1800 MHz	GSM + LTE 10-20 MHz
900 MHz	GSM + HSPA 5 MHz
800 MHz	LTE 10 MHz

HSPA/LTE radio evolution improves spectral efficiency thus increasing capacity in cells

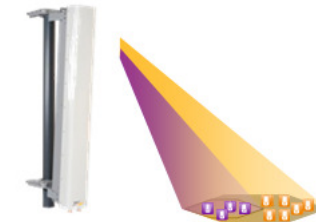
- HSPA+, LTE, LTE-A

Efficient macro sites



6-sector site

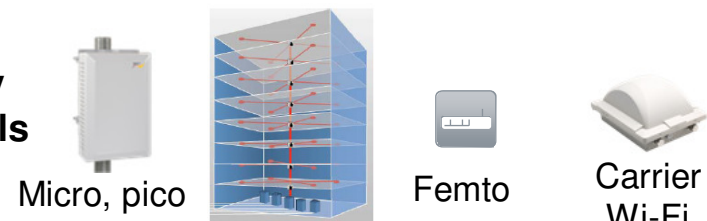
- up to 80% more capacity compared to 3 sectors
- up to 40% more coverage



Active antenna

- up to 65% more capacity compared to standard sector
- up to 30% more coverage

More capacity with small cells

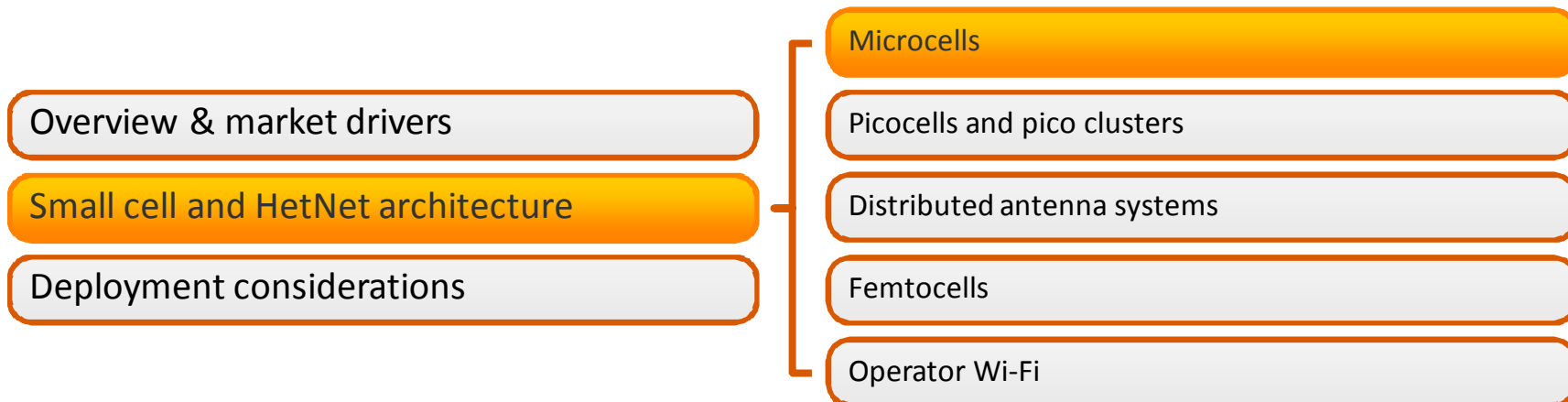


Micro, pico

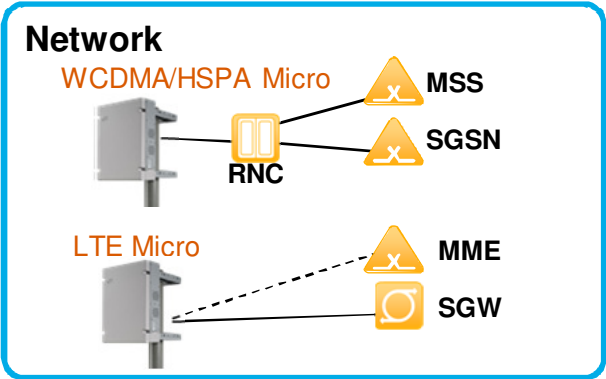
Femto

Carrier Wi-Fi

Contents



What are micro base stations?

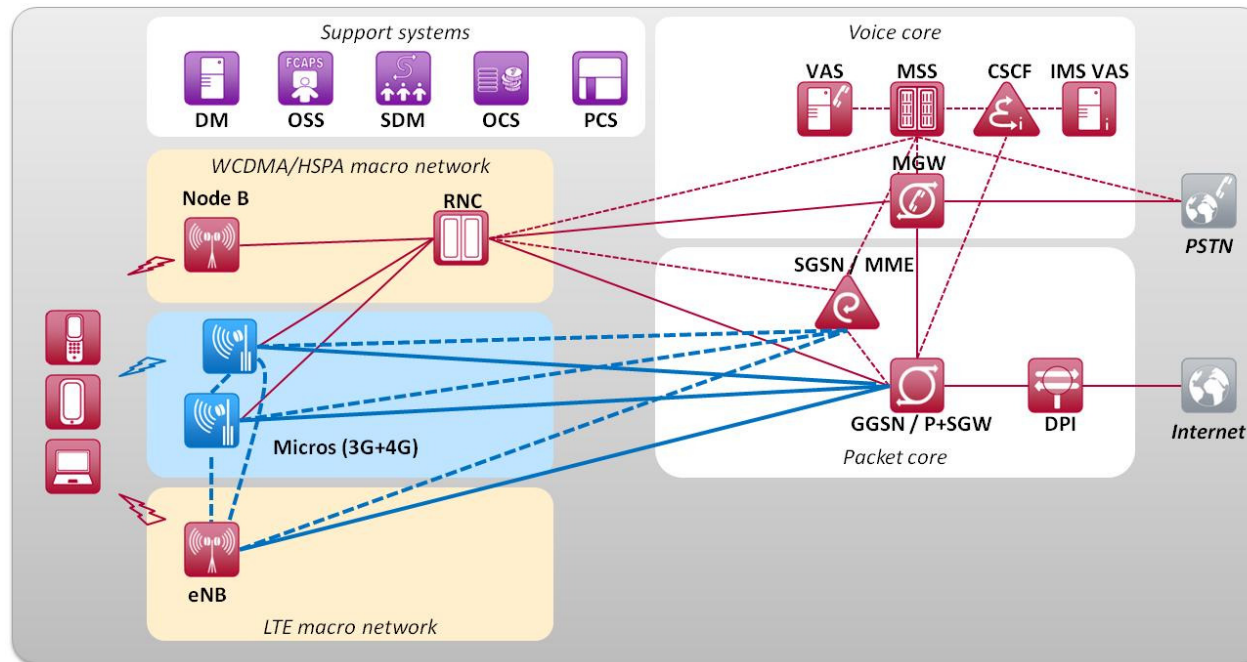


- Outdoor**
- Output power 1-10W, typically 5W
 - Cell size typically 100s of meters
 - BTS size 10 – 50L, expectations about 10L
 - Small configurations, typically 1-2 cells/1 cell MIMO
 - Typically 50-200 3G/4G users per BTS

- Deployment on wall, roof top and utility pole
- Small antennas typically quite close to users e.g. street level (short safety distance)
- Mainly outdoors, but possible also indoors e.g. airports, shopping malls and railway stations
- Medium BTS and site cost

- Utilize macro network topology
- Same features as macro cells
- Planned deployment & full mobility
- Dedicated or macro shared carrier
- For traffic hot spots or coverage fix
- Capacity & coverage when macro cell deployment is not feasible
- Fixed broadband and microwave backhaul

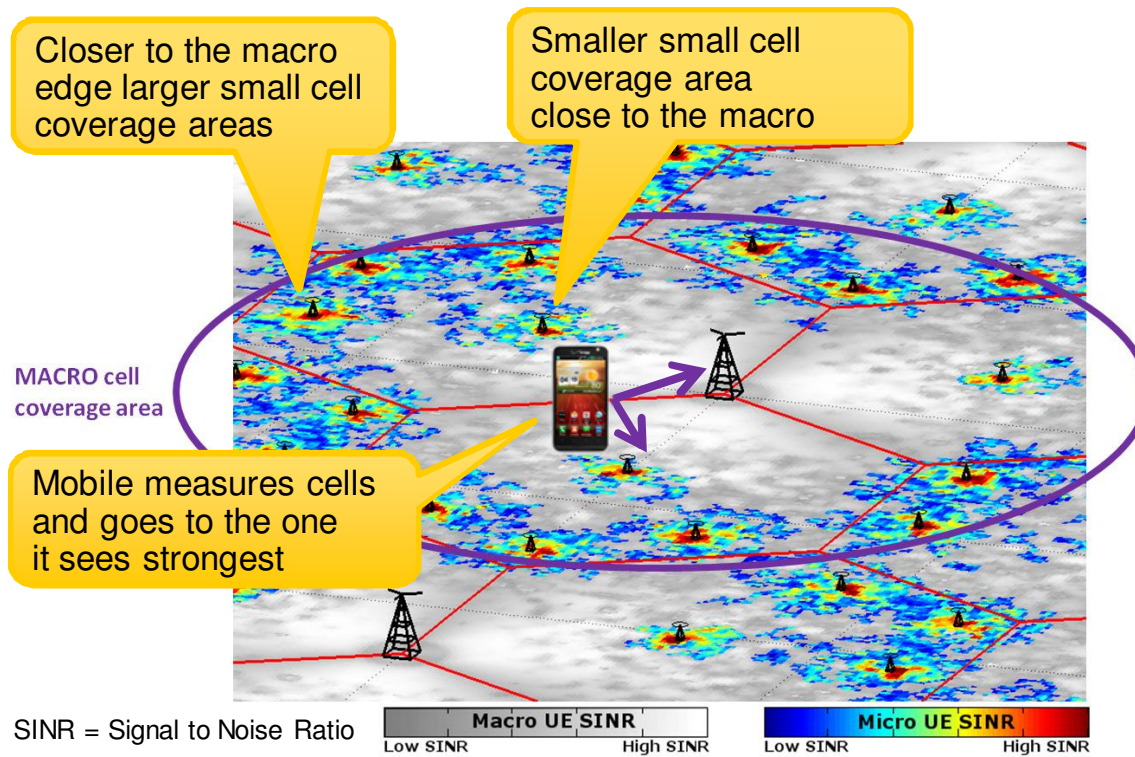
Micro uses common architecture with macro



WCDMA/HSPA: connected to RNC with same lub-interface as macro Node B

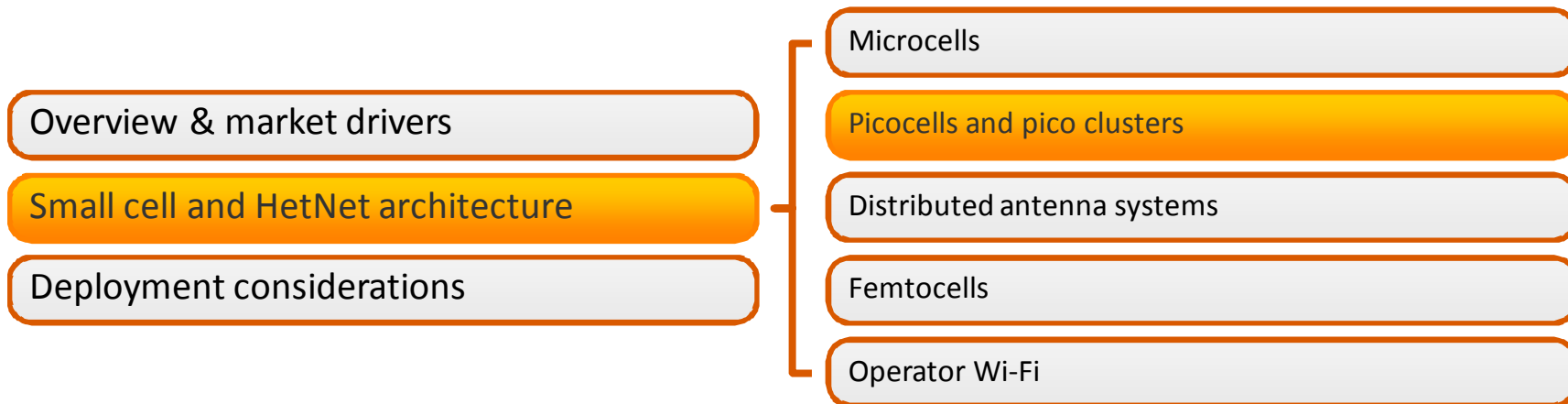
LTE: connected to MME+SGW with same S1-interface as macro eNB.
X2 links needed between micro + surrounding macros/micros

Learnings from a LIVE co-channel micro cell deployment



Macro-cell RSCP level [dBm]	On street co-channel 3G micro-cell radius [m]
-85	< 200
-75	100
-65	75
-55	< 50

Contents

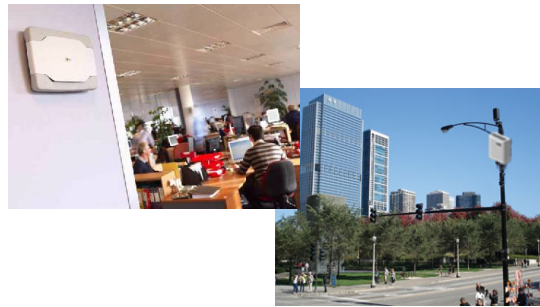


What are pico base stations?

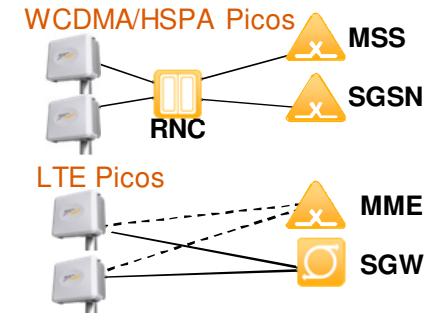
Base station



Site



Network



Indoor

- Output power 100-250 mW
- Size 2-4 L, 1-3 kg

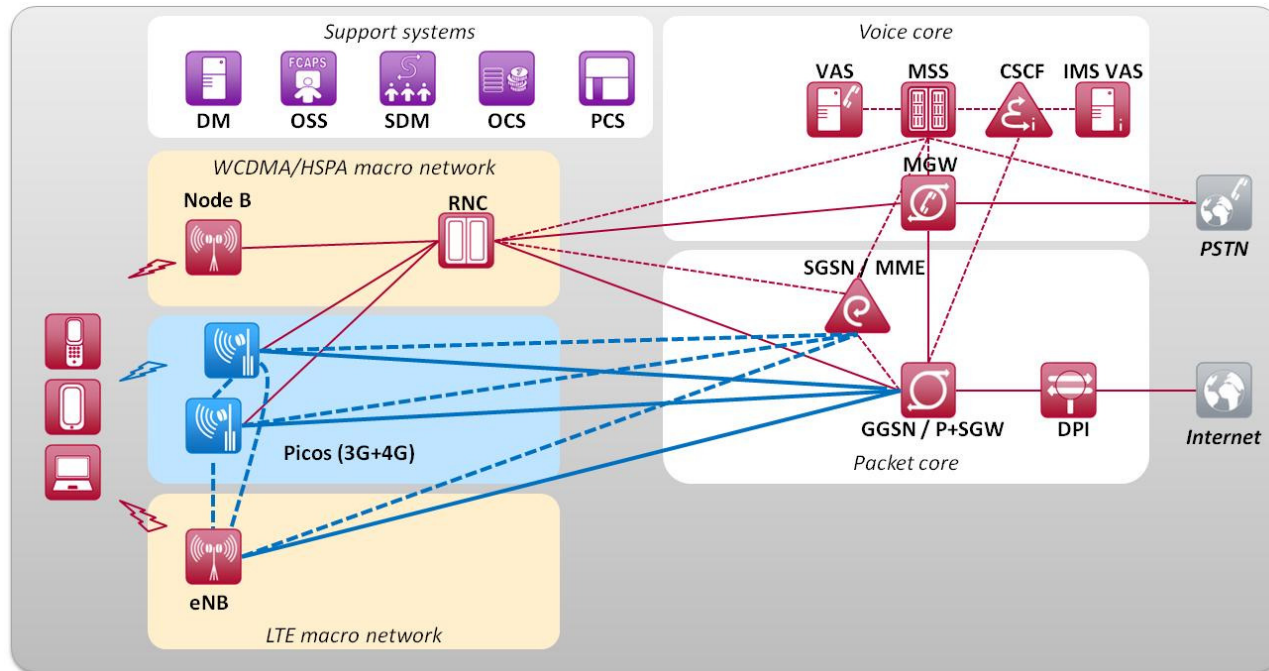
Outdoor

- Output power 1-5 W
- Coverage radius 10s of meters
- Size 5-10 L, 5-10 kg
- Integrated antenna
- Simultaneous users 16-64

- Indoor building visible location
- Outdoor lamp posts, building walls and utility poles
- Easy site acquisition and rental costs
- Requires low cost high speed backhaul transport solution
- Requires network planning, operator installation

- From network architecture perspective looks like macro cells
- Could be a subset of features and functionalities of macro cells
- Dedicated carrier (frequency) or same as for macro
- Indoor coverage/capacity or outdoor street level capacity solution

Traditional Pico architecture



WCDMA/HSPA: connected to RNC with same lub-interface as macro Node B

LTE: connected to MME+SGW with same S1-interface as macro eNB.
X2 links needed between picos + surrounding macros/micros/picos

What are pico clusters?

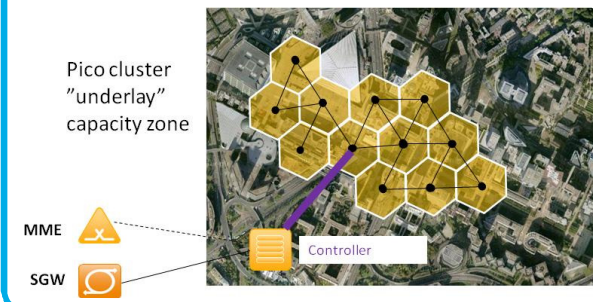
Base station



Site



Network



Indoor

- Output power 100-250mW
- Size 2-4 L, 1-3 kg

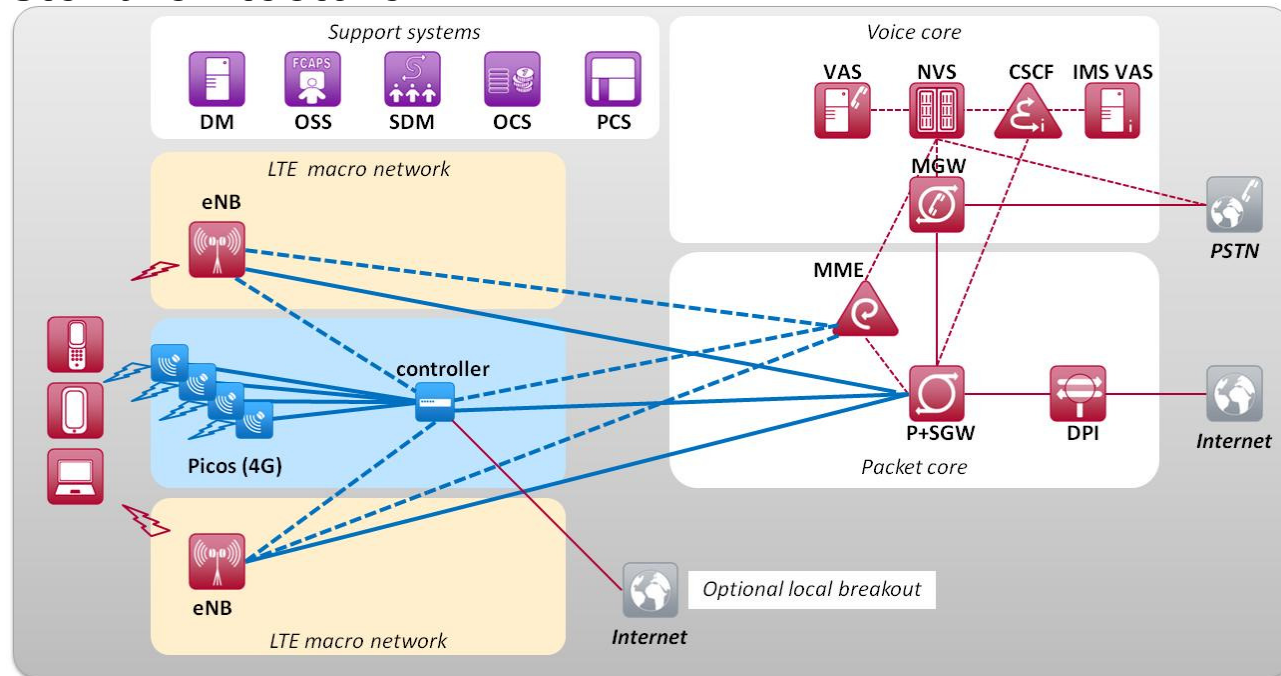
Outdoor

- Output power 1-5 W
- Coverage radius 10s of meters
- Size 5-10 L, 5-10 kg
- Integrated antenna
- Simultaneous users 16-64

- For areas where larger number of neighboring pico cells used to build outdoor “underlay” capacity zone or indoor small cell coverage/ capacity cluster
- Otherwise similar characteristics as with traditional pico sites

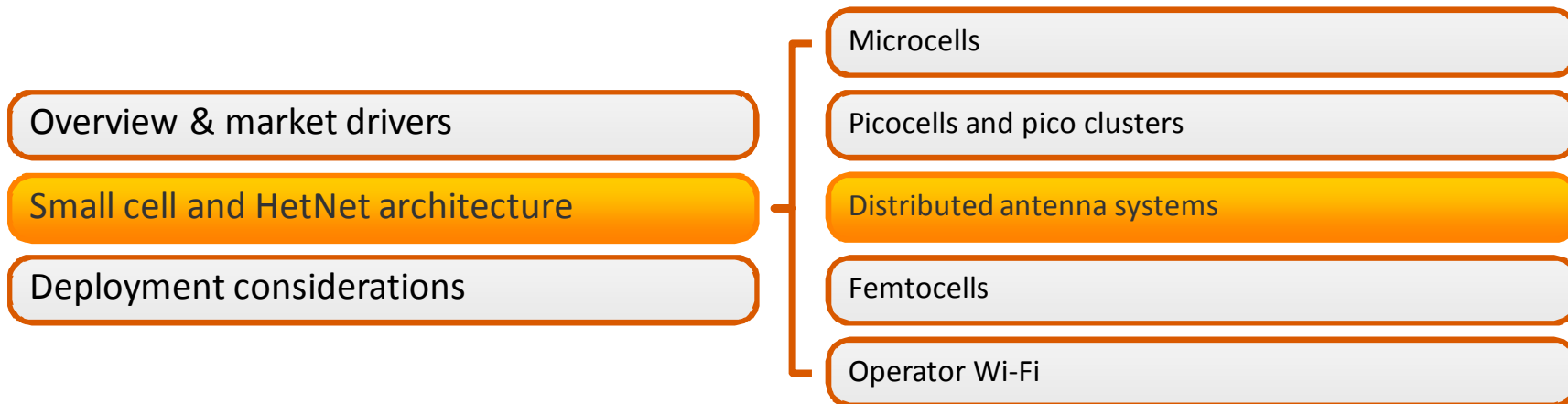
- Controller taking care of cluster internal signaling & mobility
- Dedicated carrier (frequency) or same as for macro
- Indoor coverage/capacity or outdoor street level capacity solution

Pico cluster architecture



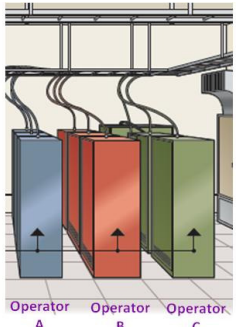
LTE: The entire cluster looks like one S1 connection to MME+SGW. No X2 links needed between the nodes inside the cluster, towards surrounding macros X2 links from the controller.

Contents




What are distributed antenna systems (DAS) ?

Base station




Operator A Operator B Operator C

Site

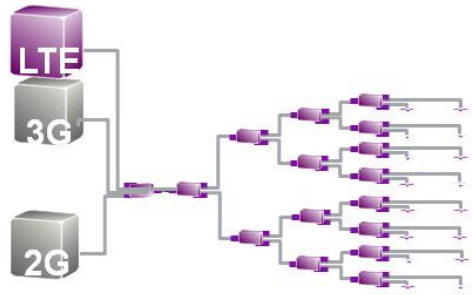


Indoor antenna



Outdoor antenna

Network



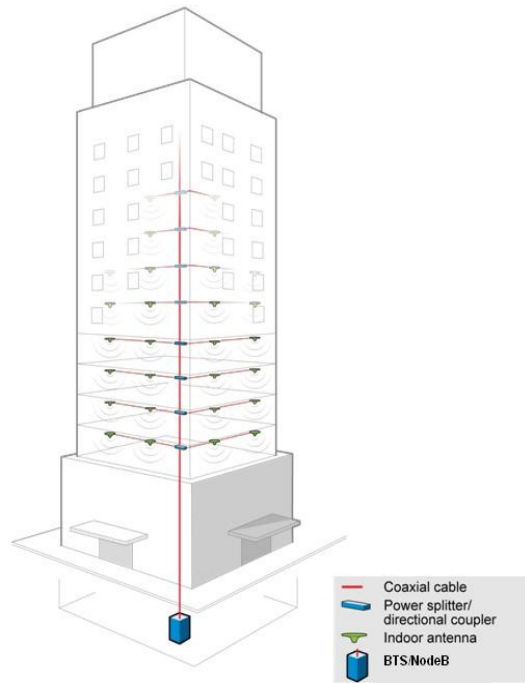
Macro BTS

- Typically normal macro BTS connected to the DAS
- DAS can support sharing the antennas between multiple operators base stations

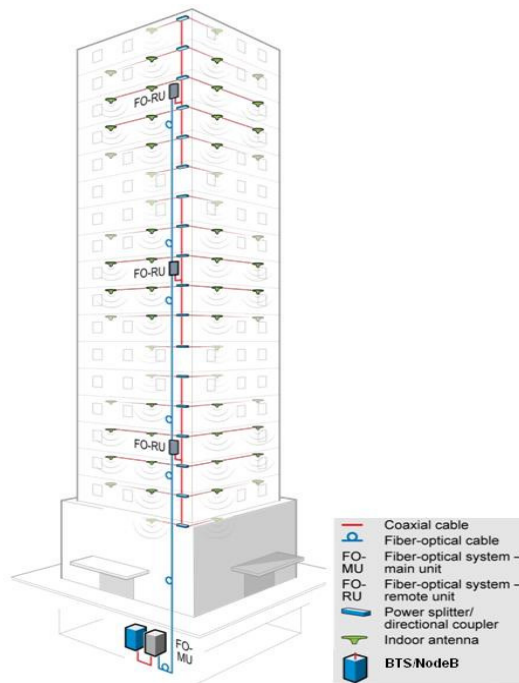
- Small indoor antennas in various building locations
- Outdoor lamp posts, building walls and utility poles
- Requires special DAS cabling in the buildings or outdoor area
- Requires network planning, operator installation

- From network architecture perspective looks like macro cells
- Macro features and functionalities
- Passive, active and hybrid options
- Shares carrier with macro
- Can be operated by 3rd party operator-independent companies
- Especially used as multi-operator indoor coverage solution

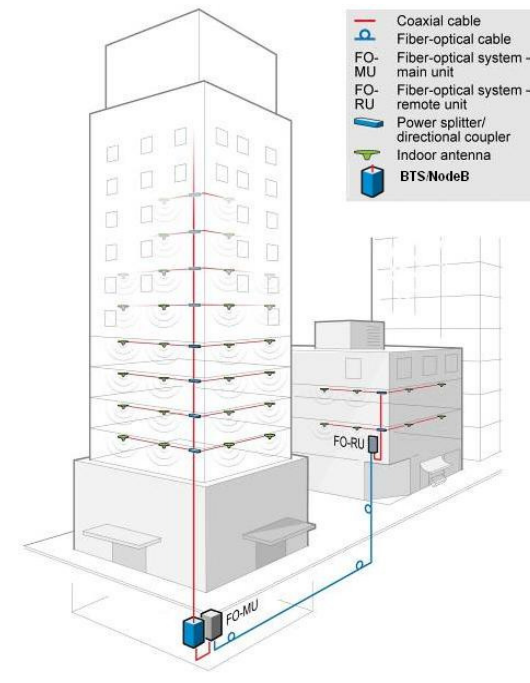
DAS Solution Examples



PASSIVE DAS



ACTIVE DAS



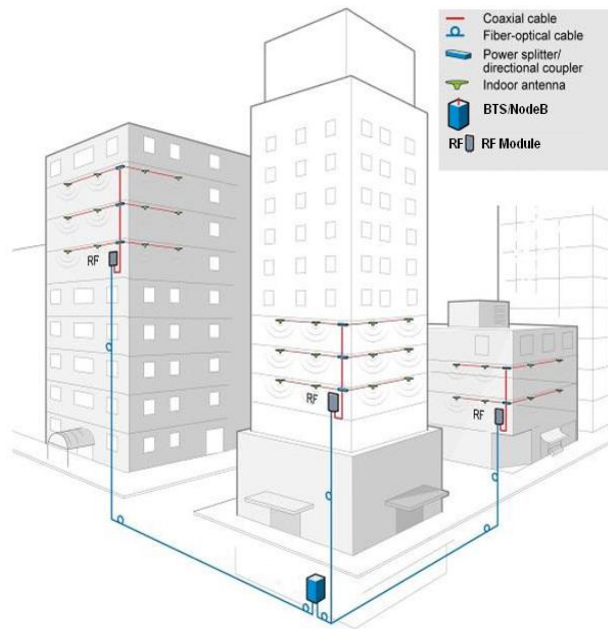
HYBRID DAS

- Coaxial cable
- Fiber-optical cable
- FO-MU Fiber-optical system – main unit
- FO-RU Fiber-optical system – remote unit
- Power splitter/directional coupler
- Indoor antenna
- BTSNodeB

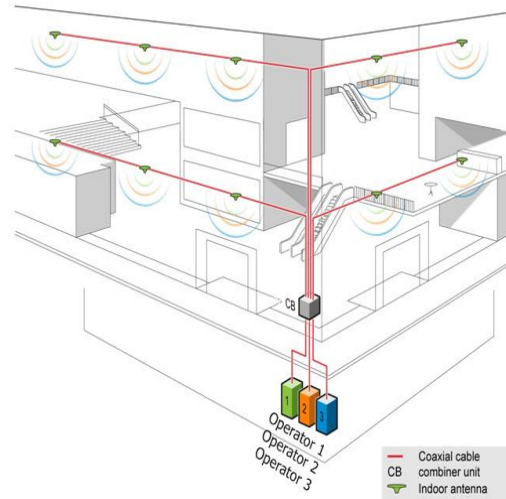
- Coaxial cable
- Power splitter/directional coupler
- Indoor antenna
- BTSNodeB

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- Indoor antenna
- BTSNodeB

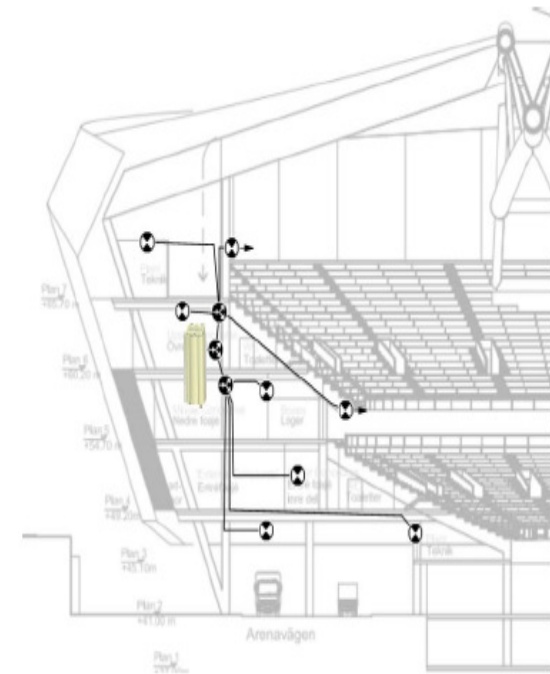
DAS Solution Examples



Distributed BTS



Multi Operator – Multi Technology DAS



Outdoor DAS for Stadium

What are outdoor DAS systems ?

Outdoor DAS
 Capacity or coverage needs
 Tough permitting environments
 Densely populated areas



- Using lamp posts and similar infrastructure
 - Typically run by dedicated companies that lease capacity to mobile operators
- Today used especially in big US cities

