Brancheverenigging
ICT en Telecommunicatie Grootgebruikers

DITS

Dutch operators Indoor Technical Specification

DITS version 4.0 Final, signed by MNOs, see next pages

DITS total pages 1 to 43

Approved by MNO : T-Mobile, KPN, VodafoneZiggo

Date of approval : see next pages

Approved by (Name) : see next pages

Signature : see next pages

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Approved by MNO	: T-Mobile Netherlands B.V.
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21-11-2019	DITS Final	4.0	MNOs	Signing by MNOs

INHOUDSOPGAVE

SCOPE

This document defines the technical requirements of a **passive** indoor cellular system for GSM, UMTS and LTE technologies, referred to in this document as a Passive Distributed Antenna System (**P-DAS**). It also covers the design and test requirements as well as the characteristics of the elements used in the system where the network performance is affected. It furthermore lists all frequency bands licensed and (where information is available) planned or considered to be licensed to Dutch Mobile Network Operators (**MNOs**).

In addition, it defines the scope of work, the responsibilities and the expected deliveries from the parties involved in the different phases of a project.

This document is only to be used for the design and testing of a P-DAS for regular buildings and (regular) usage. This means that large public locations (e.g. railway stations, airports, big event locations) with specifically high capacity and performance requirements are excluded. Specific customer demands, such as support of C2000, are not covered by the current document, an interaction with the operators is required. Other indoor cellular solutions and future technologies, such as 5G, provided by new or existing service providers may be covered in separate or updated documents.

This document describes the technical requirements of one or more P-DAS'es. Any agreements of a commercial and/or legally binding nature on service delivery are outside the scope of this document and are for each MNO and Property Owner (**PO**) / Neutral Host Contractor (**NHC**)/ Lessee of the property to be decided separately. The arrangements for the delivery of the service are done bilaterally between each MNO and PO, NHC or Lessee of the property. The PO or Lessee of the property is the contract party of the MNOs and therefore accountable. In case the PO uses a NHC, the NHC will be responsible for the P-DAS.

PURPOSE

This document will be used by the NHC as a reference for the design and implementation of a P-DAS for the GSM, UMTS and LTE technology, if such is required by POs as a basis for the technical specification thereof in a Request for Quotation (**RFQ**). Any of the MNOs will use this document as a basis for validation.

1 INTRODUCTION

This document has been composed by the MNOs, in cooperation with and facilitated by BTG. In order to ease the design and implementation of a P-DAS for GSM, UMTS and LTE multi operator networks, this document specifies how a P-DAS should be designed such that it adheres to the quality standards of the MNOs as referred in this document.
In case a single operator network over a multi-operator is desired, more details can be provided separately by a service provider.

A P-DAS can take the form of a single radiating element or distributed radiating elements which can use omni antennas, sector antennas, radiating cables or a combination of these together with RF components and sub-systems.

The DITS is composed for a multi-operator solution based on the current three MNOs. MER and SER standards in the DITS are in this way scalable depending of the amount of (future) connecting MNOs to the P-DAS.

In the Netherlands several parties are involved in the design, building and maintenance of a P-DAS. A PO that owns the property or represents a natural or legal person that owns the property typically buys or rents the P-DAS. The P-DAS will be designed, installed and tested by a NHC who has the full turn-key responsibility for delivering such system in accordance with the requirements defined in this document. The NHC can be either an independent third party or one of the MNOs.

In many cases, the implementation of a P-DAS is separated from requests towards MNOs for delivering the actual GSM, UMTS and LTE signals. This document should only be used by POs and NHCs for the design and implementation of a P-DAS, and is therefore independent of the signal delivery to the P-DAS by one or more of the MNOs.

It is expected that the NHC will be responsible for the maintenance of the P-DAS. Section 4 provides recommended elements of a high level Service Level Agreement (SLA). The PO is responsible for arranging maintenance contracts with the NHC and the MNOs separately.

A design of a P-DAS will in principle be accepted when the NHC verifies and demonstrates to the MNO that the specifications defined in section 2 are met.

1.1 ROLES OF THE INVOLVED AUTHORS.

The realization of this document has been facilitated by the BTG and is written by representatives of the three MNOs that are active in the Netherlands at the time this document enters into force: T-Mobile, VodafoneZiggo and KPN.[1]

The document complies with the principles laid out in chapter 1. During the working sessions (lawyers of) CMS were present to monitor the discussions and, where appropriate, to provide competition law advice. CMS also reviewed, from a competition law point of view, material produced

[1] Before the merger of Tele2 and T-Mobile, the two MNOs provided were involved in the realisation of the document separately.

by the representatives prior to circulation and the manner in which the material has been included in this document.

1.2 APPROACH

This document is designed to clarify the technical requirements of a P-DAS. This is done according to different principles laid out in chapter 1.3. to ensure this goal is met. In addition, this document aims to have the design of a P-DAS comply with all relevant rules and regulations.

When the NHC/PO uses the document for its P-DAS, a qualifying process is described to ensure that before built and after built the (design of the) P-DAS will meet the technical requirements of MNOs and unexpected costly surprises for PO are prevented.

1.3 PRINCIPLES

- All MNOs are prepared to review and update this document after consulting with the market on the basis of the principles laid out in this section.
- The MNOs do not intend in any way to influence the market with the technical and organisational requirements laid out in this document, except to ensure that a P-DAS meets the minimum technical and organisational requirements in order for the MNOs to connect it from a technical perspective. Each PO and NHC may choose to deviate from these requirements for reasons of their own. In this case, MNOs need to be informed and may request detailed information on and testing of the P-DAS and may furthermore decide not to connect or request modifications. This principle can only apply for the buildings as defined in scope.
- The MNOs will adhere to the principles of equality, transparency, proportionality and non-discrimination in this document.
- Dutch legislation and regulations will always prevail over this document. In **Appendix C**, the most essential regulatory documents are listed. It concerns a non-exhaustive list. The NHC/PO are responsible for adhering to the most recent versions of applicable rules and regulations as well as to new regulations when designing a P-DAS.

2. TECHNICAL SPECIFICATION OF THE INDOOR SYSTEM (P-DAS)

2.1 GENERAL

1. The NHC shall base the design on this technical specification and shall engage the MNO after the scope of work has been pre-awarded by PO to the NHC in line with step 5 in issue number 66 and at delivery of the P-DAS.

2. The P-DAS shall be capable of supporting radio signals of GSM, UMTS, LTE (TDD, FDD, LTE-M and NB-IoT) technologies. Where the P-DAS incorporates other users/technologies on other frequency bands, the performance specification defined in this document shall not be compromised by the NHC.

3. The DAS shall be [designed] with the provision that the capacity handling will be according to the expected traffic and footfall targeting loading of less than 50% of a sector during the life cycle.
A) It is highly advised to use expert advice per MNO and reference buildings to ensure correct dimensioning and scalability of the system (sectorisation).
B) The PO shall specify the expected footfall and, if available, the traffic behavior of the mobile users. The traffic forecast should take both data traffic into account and should have a window of at least 5 years ahead of each MNO.
C) In case the PO cannot provide such data, a minimal experienced throughput of 20 Mbps downlink for 95% of users *measured* over the busiest hour of a month, can be used as a rough guideline for an office with WiFi. Also as a rough guideline an average user activity of 60 kbps per person (reference date 1-6-'18) in the building. Typical year-on-year traffic growth has been 75%-100%.

   Note: It should be noted that relative distribution of MNO customers over the building can be highly non-uniform and can change over time. The same is true for traffic hotspots.

4. The P-DAS shall cover the frequency bands given in **Appendix A1**.

5. The proposed P-DAS should be the most cost effective end-to-end multi operator solution utilizing the full capability of the MNO's equipment. MIMO implementation is to be agreed with the respective MNO.

6. The requirements of the P-DAS defined in this document are applied to the whole building and have a multi operator character.

7. Where a location already has a P-DAS installed for a limited number of frequency bands, the NHC must carry out an assessment of the impact of upgrading the existing system. If this is not possible, the MNO should be contacted.

8. The P-DAS shall be of a modular construction, so that it can be easily expanded and upgraded for capacity reasons by way of sectorization into additional P-DAS zones, utilising the initial or new SER locations.

9. The upgrade shall minimize the disruption to the current operations. The upgrade shall be coordinated by the NHC with the relevant MNOs, enabling them to communicate changes to customers and internal departments.

10. All frequency bands shall be carried on the same sub-system.

11. This document defines the technical specifications for a P-DAS supporting the operation of

- GSM at 900MHz & 1800MHz bands
- UMTS at 900MHz, 1800MHz & 2100MHz bands and
- LTE at 800MHz, 900MHz, 1800MHz, 2100MHz & 2600MHz bands
- However, all passive components must be wide band covering both GSM, UMTS and LTE bands as given in **Appendix A1** except specific band selective units for the purpose of channelization and filtering.
- to be able to support non MNO-systems (such as C2000) on the P-DAS the passive components should also cover additional frequency bands. **Appendix A2** lists (non-exhaustive) a number of systems and relevant spectra that may be considered.

However, all passive components must be wide band covering both GSM, UMTS and LTE bands of both the mandatory and recommended frequency bands as given in Appendix A1 except specific band selective units for the purpose of channelization and filtering. Consideration can be taken if required to support non MNO-systems (such as C2000) on the P-DAS, and if required the passive components should also cover these specific additional frequency bands, Appendix A2 lists (non-exhaustive) a number of systems and relevant spectra that may be considered.

12. In terms of LTE, the baseline requirement is referred to the SISO P-DAS. As an alternative, but not mandatory is 2x2 MIMO, a P-DAS solution allowing higher data speeds through 2x paths but requiring double infrastructure and MIMO 2 port antennas. > 2 path not considered.

13. The P-DAS shall be designed to operate with a base station and a mobile terminal meeting the 3GPP and ETSI standards. Additionally, the P-DAS shall conform to all the current regulations, rules and the operation conditions imposed on MNOs by the local, national and European regulators and meet the 3GPP standards where appropriate. Reference is made to the non-exhaustive list in **Appendix C**.

14. When an enhancement is made or an extension is added to an existing system, it must be ensured that it complies with all applicable standards and regulations set out under issue number 13 and the non-exhaustive list in **Appendix C**.

15. All MNO radio sources that must be connected into the (multiple) P-DAS should be centralized in a MER or SER for cost efficiency. For every passive P-DAS system, the P-DAS starts from a MER or SER.

For each MNO separately, all radio sources (for one P-DAS sector) should be combined on one coaxial cable. A separate connecting point will be made available for each of the MNOs. This will be the demarcation point between the NHC and the separate MNOs. For capacity or Link budget reasons, a P-DAS can consist of one or more sectors.
For every P-DAS-sector at the "connecting point" (POI) only one coaxial input is available per MNO. (e.g. Hybrid combiner). This will be the demarcation point between the NHC and the individual MNO. Every P-DAS starts from Point B in figure 1 and often with a "tree structure".

BTS Hotel
BTS Hotel Radio sources (BTS's) from all MNOs will be installed in a MER and for a P-DAS with more than one sector, extra RRHs from the MNOs can also be installed in one or more SERs close to the sector POI. This depends on, available space, Link budget and cost efficiency considerations. Every MNO has its own floor/ wall space prepared for installing (BTS) cabinets or mounting RRHs and also if space allows, for future capacity expansions (and/or new technology/frequency extensions). The room should be air-conditioned (either; passively or electrically) and sufficient mains power should be made available by the NHC/PO for the initial configuration. Floor space for battery backup (48V) should be considered only if space is available. For information about initial required floor/wall space and mains power, please contact each individual MNO.

2.2 DESIGN REQUIREMENT ASSUMPTIONS

16. Where the P-DAS is used for in-building a propagation prediction model for Fast Ray Tracing should be used, with the following settings:
- Prediction height on 1.5 m.;
- body loss 6 dB;
- BTS Noise Figure 4 dB;
- cell load 50%, mobile terminal travelling speed up to 3 km/hr.;
- service continuity;
- cell overlap max. 20%;
- indoor dominance ≥6 dB.

Indoor dominance is a moment in time and very much depending on the MNO's network changes. Can be determined before design by measurement, but then a validity date of measurements should be defined to avoid discussions after design. Eg, 6 months after measurement and planned networkupgrades.
In case of a new building the NHC shall deliberate with the MNOs on base of his building modelling and drivetest on the ground.

The 3D model should represent the building to be covered in a realistic way, including floors, inner and outer walls as well as stairs and elevators, if relevant for coverage. All building materials should be chosen and modelled according realistic values for reliable predictions. For radio design validation and approval by the MNOs,

details should be made clear. The following items should be delivered by NHC to MNOs:
- Radio design;
- Indoor measurements;
- Floorplan;
- Coverage Simulation for all requested technologies in 3D with legend;
- Equipment list;
- Link budget per antenna;
- Compliancy report design level, quality, ICNIRP.

At the moment of drafting this document, the MNOs generally use iBwave design Enterprise for indoor radio design. Licenses and knowledge are available for validation.
Providing radio designs for validation in another format is not precluded but may cause extra workload, delay, additional costs and/or introduce errors.

17. Each of the MNOs shall provide the NHC and/or the PO with a specification package detailing the mechanical, electrical, thermal and RF interface specifications of the base station equipment. This will be provided, if necessary, under the condition that a Non-Disclosure Agreement (NDA) of the MNO is signed by the NHC and/or PO in order for the MNO to comply with its confidentiality agreement with their equipment vendors. For more details, please refer to **Appendix D** and issue number 25.

18. Where information is not given by the MNO, the NHC can assume

    - the 2G, 3G and 4G base station receiver noise figure of 4dB,
    - Mobile terminal (Ue) maximum transmit power of 30dBm, 33dBm and 23dBm for GSM, UMTS and LTE respectively,
    - Mobile terminal minimum transmit power of 5dBm, 0dBm, -50dBm and -40dBm for GSM900, GSM1800, UMTS and LTE respectively,
    - the dedicated P-DAS should provide at least a dominant coverage of 6dB over 95% of the coverage target area against the coverage provided by the external outdoor cell sites of any adjacent cellular networks.
    - the dedicated P-DAS delivers CPICH Ec/Io >= -8dB with reference to the UMTS cells of 20% loading (10% CPICH and 10% control signaling)
    - a carrier-to-noise (C/N) ratio of 12dB for GSM voice calls in uplink and downlink, and
    - 10% (may differ per MNO) downlink RF composite power per 3G operating channel assigned to Common Pilot Channel (CPICH)

- Reference Signal (RS) power of LTE may usually be with 3dB boosting as shown in table 1. Although the RS may be with 3dB power booster, the average sub-carrier power of LTE will still remain as

  $$P_{FL} - 10 \times \text{Log10}(N_{sc}) ,$$

  where P_{FL} is referred to the full load channel carrier power and N_{sc} is the number of LTE sub-carriers in a given LTE channel bandwidth. There may be some special cases in which an individual MNO may implement a power booster on RS power different from 3dB. In such a circumstance, the individual MNO will advise the NHC on the specifics.

carrier power [W]	carrier power [dBm]	LTE channel bandwidth [MHz]				LTE channel bandwidth [MHz]			
		5	10	15	20	5	10	15	20
		number of LTE sub-carriers within a given channel bandwidh				number of LTE sub-carriers within a given channel bandwidh			
		300	600	900	1200	300	600	900	1200
		Transmit Reference Signal power with *3dB power booster* [dBm]				average power of each sub-carrier [dBm]			
5	37.0	15.2	12.2	10.5	9.2	12.2	9.2	7.5	6.2
10	40.0	18.2	15.2	13.5	12.2	15.2	12.2	10.5	9.2
15	41.8	20.0	17.0	15.3	14.0	17.0	14.0	12.3	11.0
20	43.0	21.2	18.2	16.5	15.2	18.2	15.2	13.5	12.2
30	44.8	23.0	20.0	18.3	17.0	20.0	17.0	15.3	14.0
40	46.0	24.2	21.2	19.5	18.2	21.2	18.2	16.5	15.2

Table 1 : Reference Signal & Sub-carrier power of LTE.

19. There may be some specific cases in which a different power class of base station, i.e. micro, pico, small cell, etc., may be used and NHC will be advised accordingly in the pre-feasibility/ feasibility phase of the project.

    Every MNO should be able to deliver ≥ 40 dBm (max. 43 dBm) composite power per carrier (for all technologies and frequency bands [**Appendix A1**]) at the POI. 40 dBm should be used for Link budget calculations. The use of attanuator is a part of the BTS. The NHC have to provide the MNO with the input power per carrier at the POI. In case Link budget analysis shows that the design receive levels can be met using lower composite power, it may be feasible to use lower power or different base station power classes.

20. Indoor coverage provided by a passive P-DAS is an extension of the macro network coverage. Service continuity (e.g. cell reselections and handovers from and to the indoor cell and between indoor cells) should be ensured through implementation of overlapping coverage areas whereby the speed should be taken into account (3km/h) as well. Depending on the technologies used (GSM/UMTS/LTE) and the MNO network settings, the maximum and minimum time needed to complete the handover procedure without failures is respectively 10 and 4 seconds and during that time both cells should be available to the mobile But, contained with-in the building perimeter, ideally with-in or to a maximum of approximately 6 meters outside the designated exit/entrance portals, without breaching the controlled leakage requirements defined in section 2.7.

21. The following Link budget assumptions can be used for the purpose of the system design. The table below can be used as a reference for other technologies and frequencies.

Technology	***Frequency band***	***Downlink Link budget (from POI input to mobile)***		
		Zone A	**Zone B**	**Zone C**
LTE (new reference)	*1800 MHz*	*122 dB*	*117 dB*	*107 dB*

For 4G: 40 dBm composite power/carrier @ POI input
Carrier BW=10 MHz
RSRP= -27.8 dB from composite power
Design levels (RSRP) : zone A= >-110 dBm, B=>-105 dBm, C=>-95 dBm.
Horizontal feeder loss (total path loss): maximal 27 dB from POI to each antenna

2.3 THE P-DAS

22. The P-DAS will comprise of a number of network sub-systems and interfaces as shown in figure 1.

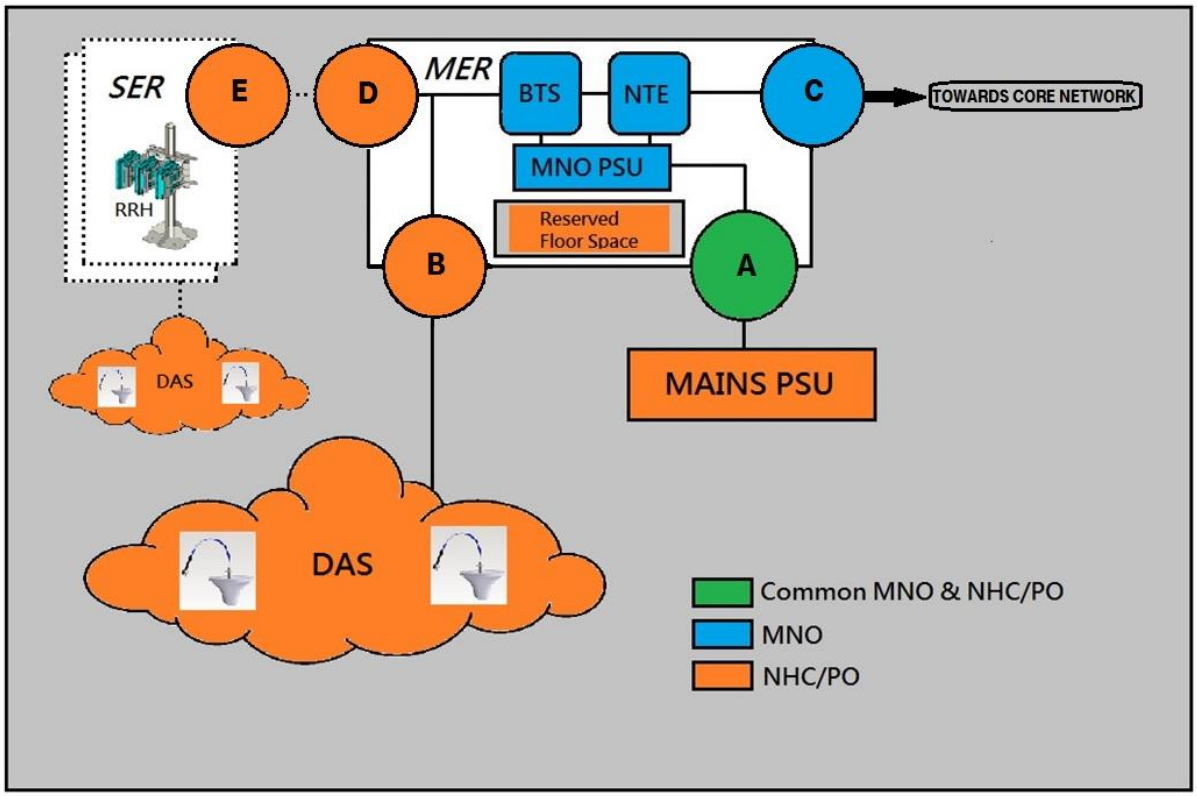

Figure 1: Schematic diagram of P-DAS system

BTS:	Combined Base Transceiver Stations per MNO
NTE:	Network Transmission Equipment for connecting the traffic to the core network, (can be more than one) per MNO
MNO PSU:	MNOs Power Supply Unit(s) for BTS and NTE per MNO
MAINS PSU:	NHC Mains Power Supply Unit
A:	Interface with the Mains Power Supply
B:	Point of Interconnect (POI) with each MNO's equipment
C:	Interface with the external transmission connections (responsibility MNO)
D:	Point of fiber interface (MER). To be discussed with MNO
E:	Point of fiber interface (SER). To be discussed with MNO
P-DAS:	Distributed Antenna System
MER:	Main Equipment Room
SER:	Satellite or Secondary Equipment Room
RRH:	Remote Radio Head

23. All the blue marked components of figure 1, including any cables connected to the MNO's equipment, are the responsibility of the MNO.

24. The P-DAS is made up of passive elements and the interface point B. The passive elements can be made up of filters, couplers, antennas, coaxial feeders and/or radiating cables.

25. The NHC and/or PO is responsible for the P-DAS, the MAINS PSU and an interface point (A) so that the MNO can connect its equipment to the power supply. The NHC and/or PO is also responsible for the provision of a proper and properly air-conditioned accommodation for the installation of the MNO's equipment, and provision of space for the installation of external transmission equipment (C) such as leased circuit or external microwave radio and/or power back up. It is beneficial to plan room for additional equipment, e.g. frequency bands.

2.4 COVERAGE

26. The coverage requirements are referred to both downlink and uplink within the coverage target areas of the LOI and with a mobile terminal at a height of 1.5m above the local ground.

27. Unless specified in a separate agreement between the NHC and the individual MNO, the NHC shall ensure that the P-DAS delivers coverage to the standard defined in Table 3 below. PO together with help from NHC should indicate the different Zone's in the building.

LTE user equipment			
Type of zone	Zone A	Zone B	Zone C
	Low density users Low data demand	Low density users high demand	High density users High demand

Typical area	Parking garages	Office space	Meeting rooms / public spaces
Impact	20% traffic density (average user throughput x users per m2)	100% Traffic density	250% traffic density
95% downlink reference coverage (reference signal received power)	> - 110dBm	>-105dBm	> -95dBm

Table 3: Coverage specification.

28. The NHC shall define and document the zone types in each design.

29. The NHC must make allowances for the floor variations, fading, clutter loss and environment etc. in the design in order to ensure the required percentage of the agreed areas of the LOI covered. Reference is also made to issue number 16. Very important areas to be covered should be made clear. (e.g. entrances, director office, canteens, meeting rooms, etc.).

30. For the 3G and 4G, busy traffic zones such as Zone C do not necessarily mean that more antennas will be required. With the placement of the antennas (including radiating cable if appropriate) it shall be taken into consideration that the demand of more data is most likely at places where the mobile terminal can be stationary or quasi-stationary such as canteens and meeting rooms etc.

2.5 COVERAGE OVERLAP BETWEEN RADIATING ELEMENTS OF P-DAS

31. The NHC shall design the coverage delivered by each antenna of the P-DAS in a manner to ensure that it has adequate overlap without discontinuity of service in the coverage area.

32. This requirement for coverage overlap also applies to boundaries where sectorization is most likely to be employed when capacity expansion is required. Based on the local knowledge of the location, the NHC shall highlight these boundaries within the P-DAS.

33. Where multiple cells are proposed, the cell boundary shall have adequate coverage overlap enabling a mobile terminal to complete a handover within the handover time defined in issue number 20.

34. Any sectorizations of the P-DAS shall be designed to minimize the handovers between them.

35. The design shall be flexible to allow later addition of sectors to meet a growing traffic demand. At this stage, the MNOs consider 500 active users per cell (per band) as a reasonable assumption, hotspots excluded. Reference is made to issue number 3.

36. The coverage overlapping areas provided by any two adjacent indoor cells of the P-DAS shall be less than 20% with reference to

- the coverage target area of that particular two indoor cells and also
- 3dB link loss window as shown in an example of figure 2 below.

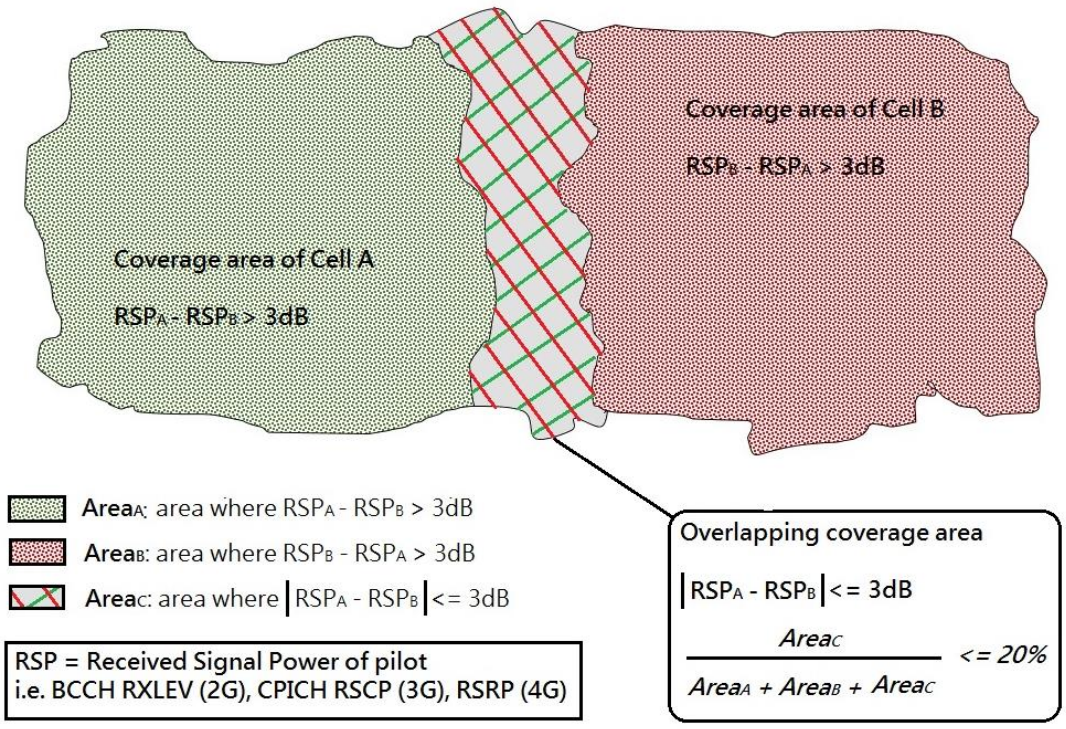

Figure 2: Coverage overlapping illustration of any two adjacent indoor cells

37. No area of the LOI shall be simultaneously served by more than 3 indoor cells.

2.6 COVERAGE OVERLAP BETWEEN THE INDOOR CELL AND OUTDOOR CELLS

38. The NHC shall position some of the antennas of the P-DAS so that the portal shall be adequately covered without breaching the controlled leakage requirements defined in section 2.7. This shall ensure service continuity in both directions between the

indoor cell and the outdoor cells which are defined as the cell(s) not under the responsibility of the NHC. The indoor cell shall not become signal strength dominant in the outdoor area.

2.7 CONTROLLED LEAKAGE AND HANDOVER

39. Outside of the building P-DAS coverage primeter, the macro signals should remain signal strength dominant to indoor signals for all technologies and frequency bands, as defined by; 3 meters or more from the building P-DAS coverage primeter or for portals maximum 6 meters as defined in section 2.2, 20.
The NHC should make sure that the indoor signal experienced outdoor is at least 10 to 15 dB lower than the local macro signal (e.g. from 3 meters or more out off the wall). An exception applies to LTE RSRP: if the outdoor macro signal is lower than -100 dBm, the indoor level as experienced outside shall also be lower than -100 dBm.

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2.8 OVERLOAD AND INTERMODULATION

40. The selection and the placement of the radiating elements of the P-DAS shall not cause overloading, blocking and de-sensitization to the mobile terminal in the downlink direction, and the MNO's base station in the uplink direction due to the presence of a mobile terminal transmitting at full power within the coverage range of the radiating element, or Passive Intermodulation (PIM) created by the mixing of two or more strong RF signals from a nonlinear device, especially in close proximity to the radiating element concerned.

41. The minimum coupling loss (MCL) refers to the location where the minimum path loss between the mobile terminal and the P-DAS will occur, and the mobile terminal will receive the maximum downlink signal and the MNO's base station will receive the maximum uplink signal.

42. The NHC shall carry out an assessment for each design, state the MCL which will be achieved and ensure the downlink and uplink overload, blocking and de-sensitization will not occur. The maximum downlink signals at a 2G, 3G and 4G mobile terminal shall be less than -40dBm, -25dBm and -25dBm per cellular channel respectively, and the maximum uplink signal level per cellular channel at the MNO's 2G, 3G and 4G base stations shall be less than -35dBm, -52dBm and - 50dBm respectively. Consideration of alternative antenna types and/or the antenna locations and the overall system design may be necessary to achieve the requirements.

43. The NHC shall endeavor to position the radiating element such that a far mobile terminal at the edge of an antenna coverage area will not be affected by a near and uncoordinated mobile terminal at the MCL position of the same radiating element, transmitting 30dBm, 23dBm and 23dBm at the GSM, UMTS and LTE frequency band respectively. The uncoordinated mobile terminal is due to the MNO that does not subscribe to the P-DAS. The use of other than public MNO frequency bands should

be reported to the certifying parties, so that BTS blocking and other technical problems can be avoided.

44. In the absence of 3GPP specification specifically for the P-DAS, the design of the P-DAS shall ensure that the total intermodulation emissions generated by the P-DAS at the POI shall not exceed -155 dBc under full load conditions. Nevertheless specifications in Appendix C are still applicable.

2.9 CO-SITING

45. The NHC shall ensure that the system is designed, either by suitable filtering or other means, to prevent any significant mutual interference between any 2G, 3G and 4G channels of the MNO and other telecommunication installations in the premises at the time of design and installation. This includes but is not limited to the presence of GSM-R, PMR, wireless local access network (WLAN), ultra-wide band (UWB) device, RFID, LTE-U, MuLTEFire, LTE-R etc.

46. The isolation between every input port of the POI shall be at least 25dB.

2.10 HEALTH AND SAFETY

47. To check compliance with ICNIRP it is recommended to use an industry recognized ICNIRP calculation method. The calculation is based on a worst case scenario: based on the presence of all operators, maximum power per operator per band and a minimum distance of 0.3 meter to the antenna. If the worst case scenario from the calculations shows that the permitted limits are exceeded, site specific calculations must be made to show ICNIRP compliance.

48. In terms of the P-DAS design related to human exposure to electromagnetic fields (EMF), appropriate exposure limits defined by ICNIRP standard according to the implementation conditions shall be used. In addition, MNO licenses announcements in Dutch government gazette (*Staatscourant*) may further restrict field strengths, e.g. in hospital environments.

49. The NHC shall take full responsibility for the risk assessment in where the public or occupational EMF limit is applied to each radiating element. The EMF exposure limit for the general public shall be used in any publicly accessible location.

50. Maximum radiated power from any single radiating element shall not expose anyone to an EMF level which exceed the current guidelines in the ICNIRP standard.

51. In case of a later modifications (additional channels, technologies, expansions) of the P-DAS, a new ICNIRP calculation is required.

52. The NHC shall issue a ICNIRP compliance statement for every design of the P-DAS and indicates which radiating elements are compliant with the public and occupational

exposure limits, given maximum carriers deployed at full power by all MNOs. For a P-DAS where additional EMF requirements apply, e.g. hospitals (**Appendix C**), the statement shall indicate compliance for this indoor environment.

53. The BTS-hotel shall be designed to meet all the relevant building regulations in particular in areas concerning health and safety.

54. All the electrical installations shall comply with the NEN 1010 Low voltage, NEN 3140 < 1000 volts AC>.

55. With the exception of the MNO equipment (blue components in Figure 1), the NHC is fully responsible for the health and safety of the P-DAS which includes all of the components of Figure 1.

2.11 PERFORMANCE CHARACTERISTICS OF P-DAS ELEMENTS

56. The overall gain flatness of the P-DAS over the whole MNO's licensed bands per technology shall be less than 3dB. In addition, within each MNO's 3G & 4G 5MHz band and 2G 200kHz channel, the gain flatness of the P-DAS shall be less than 1dB, Effective Isotopic Radiated Power (EIRP).
This requirement does not have to be met for special locations (e.g. small rooms such as halls, elevators etc.).

2.12 POINT OF INTERCONNECT (POI) (B)

57. As a minimum, the P-DAS (POI) shall provide one interface port per sector for each MNO, combined Rx/Tx.

58. The interface impedance shall be 50 ohm with a VSWR of less than 1.4:1 at POI (B) for all MNO frequency bands (detailed in **Appendix A1)**.

59. At the POI (B)(see figure 1 in issue number 22) the RF isolation between every input port >25 dB.

60. The P-DAS, in particular all the elements for the POI (B), shall be rated to handle the total maximum composit power of 400 Watt per input port while all MNO equipment are under full load conditions.

61. The interface connector of POI shall preferably be 4.3-10 of female type connector. It is beneficial if all other connectors are 4.3-10 as well.

62. In case a MIMO P-DAS is proposed, two interface ports per individual MNO per sector are required, preferably with 4.3-10 female type connector.

2.13 SUPERVISORY

63. Each MNO is responsible for the alarm monitoring on its own BTS-system(s).

3. SCOPE OF WORK

64. The NHC shall adopt quality processes starting from feasibility conception to the completion of the installation and integration of the P-DAS.

65. This section describes the area of responsibilities and the processes that the PO and NHC shall comply with. Please note that each MNO may have a specific requirement on milestones.

66. High-level processes and responsibilities are outlined in the table below.

	Step	Issue number	Process	Initiator	Note
Signal distribution	1	71	Request for Quotation or other form of starting a scope of work	PO	The PO composes the request to one or more NHCs. In some cases, the RFQ is submitted as a formal tender. This formal tender, if applicable for PO, shall always comply with European and Dutch procurement laws and regulations.
	2	80	Intention to participate	NHC	The NHC indicate its interest of participating in the project.
	2a	85	Request for spec	PO	Deliver on request of PO all BTS specifications (every MNO)
	3	78	Design with cost	NHC	A design, based on the requirements in this document, is submitted to the PO.
	4	72	Pre proposal acceptance	PO	Indicating the pre acceptance of proposal and agree to participate in the scheme.
	5		P-DAS Design Ready to build	NHC	After having been awarded the scope of work, the NHC will prepare the design and submit it to the MNOs for approval.

	6	89+90	Design Approval	Any of the MNOs on request	Any MNO will review the design and approve when deemed correct.
	7		Proposal acceptance	PO	Indicating the acceptance of proposal and agree to participate in the scheme
	8	74+78+76	Site Access & Equipment rooms	PO	The PO shall ensure that the NHC is given site access and that sufficient space for both P-DAS and MNO equipment is available.
	9	81	Implementation	NHC	The NHC is fully responsible for the implementation of the P-DAS
	10	82	P-DAS verification	NHC	After installation of the P-DAS, the NHC shall perform a test of the P-DAS to assure proper functioning.
	10a	83	Corrections if needed	NHC	Corrections for underperformance
	10b	84	As built doc	NHC	Submit as-built document
Signal delivery	11a	73	Request for Quotation	PO	The PO composes the request to one or more MNOs. In some cases, the RFQ is submitted as a formal tender.
	11	Extra step	Pre proposal acceptance	PO	Indicating the pre-acceptance of proposal and agree to participate in the scheme.
	12	87	Installation of the MNO Equipment	MNO	BTS Hotel needs to be ready, main power supply should be ready.
	13	88	MNO Integration	MNO	Each MNO connects its equipment to the P-DAS and carriers out functional tests

					ensuring the normal functioning of their equipment, including a coverage (verification) test (measurement).
	14	83	Corrections if needed	NHC	Corrections for underperformance
	15		Protocol of acceptance	NHC/PO	Protocol of acceptance for BTS Hotel, main power and P-DAS (including fiber for interconnect SER)
			Protocol of acceptance	MNO	Protocol of acceptance for signal delivery

Table 3 Processes and Responsibility Definition

3.1 RESPONSIBILITIES

67. A successful completion of a P-DAS project relies on each initiator in the project fulfilling their responsibilities in an effective and efficient manner.

3.1.1 PO Responsibilities

68. The PO is responsible for defining the requirements, based on this document and the specific needs and wishes of the PO. The resulting Request for Quotation (RFQ) will be submitted to one or more NHCs.

69. The PO will award the contract to an NHC. Any commercial conditions are the responsibility of the PO and the NHC and MNOs are not part of this document.

70. The PO shall arrange separate agreements with each MNO for the delivery of the MNO equipment for providing signal sources to the P-DAS.

71. The PO shall provide an accommodation for the P-DAS and the MNOs equipment. The equipment room must be appropriately designed to meet the environmental, health & safety and thermal management requirements. It must be suitably air-conditioned, if necessary to accommodate all the equipment including all designed future expansions.

72. The PO shall provide an easily accessible space for a third party telecommunication provider for the installation of transmission interface point (C) as shown in figure 1.

73. The PO shall provide and install the power supply equipment if necessary, and shall provide the MNO with a main power supply connection point meeting the appropriate electrical regulations currently in force.

3.1.2 NHC Responsibilities

74. The NHC shall carry out the system design of the P-DAS, issuing the response to the RFQ and agree on commercial conditions with the PO.

75. The NHC shall submit the design to a MNO, preferably electronic and in a format that is generally used or compatible with that format.

76. The NHC shall review and amend the design, if necessary, in response to MNOs' comments on the design.

77. The NHC shall procure and supply the P-DAS equipment appropriate to the design in accordance with this document.

78. The NHC shall carry out the installation of all the equipment for the P-DAS and those in the equipment room, with the exception of the MNO's base station and transmission equipment.

79. The NHC shall improve the P-DAS where there is a performance short fall. If improvement is not possible, a formal concession application shall be submitted for MNO's approval. The project is not completed until the MNO have signed off the system acceptance certificate which will only be signed off if the system conforms to this specification, or concessions been approved.

80. The NHC shall submit an as-built report to the PO that includes at least the following:
    a. Description of the P-DAS design
    b. Approval statement from a MNO on the as built design
    c. Description and photos of the delivered installation
    d. Coverage tests based on a reference signal
    e. Approval of the MNO for as built concessions if applicable
    f. Acceptance and signature by NHC/PO

3.1.3 MNO Responsibilities

81. The MNO shall provide a standard pack of the mechanical, thermal and electrical specifications of its equipment to the PO. In addition, the MNO shall update the pack promptly when there is a revision of one or more of the specifications.

82. The MNO shall review the verification test results and approve concession applications for signal delivery, referring to 93.

83. The MNOs shall consider the proposal for acceptance and indicate the acceptance this to the PO.

84. The MNO shall install the necessary equipment and connect these to the P-DAS. Timing and commercial discussions are the responsibility of the MNO and the PO.

85. The MNO shall execute necessary performance measurements and provide the results to the PO.

3.1.4 MNO Design Approval

86. Any of the MNOs on request, shall carry out design review and shall give feedback on the P-DAS design to the NHC within 10 working days from submission thereof.

87. Any of the MNO's on request, shall participate in technical review discussions with the NHC, if necessary.

3.2 DOCUMENTATION

88. Over the course of the project, the following documentation will be provided by the NHC to the MNO.

    (a) Design Report
    (b) Concession application
    (c) System commissioning and acceptance test report
    (d) As-built document

3.2.1 Design Report

89. This report is produced by the NHC towards Any of the MNO's on request, for approval of the design, typically prior to installation.

90. The design document shall only contain technical information. Any commercial information shall be exchanged separately between PO and NHC, where necessary.

91. The report should preferably be accompanied by electronic design files, prepared in an indoor design tool. These files should be usable directly or through translation by commonly used indoor design tools.

92. The report shall have the following information as a minimum to assist the MNO to review the design.

a) An executive summary page stating P-DAS type, number of sectors & P-DAS zones being proposed, footfall of venue, number of floors, expected number of antennas.
b) Location with the postcode and lat/lon coordinates, and the site owner information.
c) A map showing the position of the location of interest (LOI).
d) Photographs showing the LOI from different angles if necessary.
e) Size and footfall figures, and resulting traffic assumptions,
f) An indication of the construction method of the LOI, such as roof type, wall types etc.
g) Current 2G, 3G and 4G network coverage where appropriate, including a description of the measurement equipment used.
h) The area over which the P-DAS will deliver the coverage is shown by a polygon(s) drawn over a floor plan, also showing the potential sectorisation and P-DAS zone boundaries.
i) System schematic diagram with the components appropriately labelled, and the Point of Interface (POI) design details. Where necessary, the loss and power at each of the major P-DAS elements shall be given. Appropriate symbols shall be used for different type of antennas.
j) Link budget calculations which shall include the link loss and coverage for the near mobile and the far mobile at the edge of the coverage delivered by the antenna concerned.
k) An overall site plan showing the location and information of all antennas, orientations and heights.
l) An appendix containing technical specifications of equipment utilised for the P-DAS, in particular if the equipment is used for the first time.
m) ICNIRP compliance calculations and statement. A calculation confirming the compliance shall be included.
n) A declaration of compliance to this specification.
o) Part list summary table
p) The system budget summary

93. The NHC shall provide a complete final design document which will detail all the agreed amendments. This document will be used as reference for the system build and acceptance verification. No change to the system design is permitted without the agreement from the participating MNOs.

3.2.2 Concession Applications

94. The NHC should advise MNO's about concessions of this specification during any stage of the project.

95. Where the NHC has not been able to deliver as promised in the design, a concession application shall be submitted prior to providing the as built report. It is noted that concessions on matters relating to health and safety shall not be granted under any circumstance.

96. The concession application shall provide the reason for the non-compliance, a drawing showing the area of non-compliance and the coverage/performance

statistics as appropriate. The application should propose how to deal with the suggested concession.

97. The MNOs shall answer to the concession application typically within 10 working days, stating either their approval of the requested concession or requirements towards the NHC for adjustment of the installation.

3.2.3 As-Built Document

98. The as-built documents are part of the handover documents from NHC to the PO, providing details of the installation, the tests carried out on the P-DAS and records all the measurements results. The as-built document shall also be made available to the MNO's.

99. In addition to issue number 81 the as-built documentation shall contain: -

(a) Approved System commissioning and all approved acceptance test reports
(b) A statement of conformance to all the health and safety regulations.
(c) Confirmation of the ICNIRP compliance and verification work carried out.
(d) Drawing showing the routing of cables.
(e) Drawings showing the location of the actual antenna positions
(f) As-built system diagram and detailed set-up.
(g) A summary table to confirm the antenna type, position, orientation, height and EIRP, and justification for any change from the design document.
(h) As-built part list summary table.
(i) Photograph showing the location of the antennas and its surroundings.
(j) A table summarizing deviations from the design.

Where the results indicate that the design target is not met, the NHC shall carry out an internal review to rectify the deficiency.
The test items are described in section 5.

4. SERVICE LEVEL AGREEMENT

100. With the exception of the participating MNO's equipment, it is expected that the NHC/PO will be responsible for the maintenance of all the equipment used in the P-DAS and the equipment room and its accessories.

101. The maintenance regime and a service level agreement should be agreed between the PO and the NHC for the P-DAS.

102. The maintenance regime and a service level agreement should be agreed between the PO and each MNO for their equipment.

103. The PO shall make arrangement permitting the MNO access to the equipment room for the maintenance of the MNO's equipment as agreed in issue number 102, and checking the functioning of the P-DAS for network quality assurance purposes.

5. P-DAS TESTINGS

104. We differentiate two separate aspects of P-DAS testing: Testing for signal distribution on the one hand, which is the responsibility of the NHC and verification testing for signal delivery on the other, which is the responsibility of the MNO.

105. The testing for signal distribution (feeder tests) is always performed before the test for signal delivery. The test is done whilst the MNO equipment is not connected to the P-DAS. The test results are available for the MNO.

5.1 P-DAS DELIVERY (TESTING SIGNAL DISTRIBUTION (NHC))

106. System acceptance tests for verifying the design and installation of the P-DAS. The main objectives are to verify the performance of the P-DAS in a controlled environment.

107. The P-DAS should be build according to the approved design. Every feeder should be measured with a reflectometer. It is recommended that all feeders of the P-DAS with reflection points <-20 dB should be replaced. (Damaged coaxial cable or connector problems). High quality prefab jumpers don't have to be measured separately.

The connection point (e.g. hybrid matrix) is critical for BTS coupling. Return loss at every individual input should be at least 20dB.

108. Measurement equipment utilized, calibration due dates and types of software, will be mentioned in the report.

109. Measurement reports are part of the as-built documentation.

5.2 VERIFICATION MEASUREMENT (RESPONSIBILITY MNO)

110. The test is performed to verify correct signal distribution within the defined area over which the P-DAS is designed to deliver the coverage.

111. The test will be carried out for all delivered networks and their corresponding frequency bands. The measurement will be performed as walk test where results will be plotted on the floorplans.

112. Measured parameters include: Signal strength, signal quality and (optional) cell identification distribution for all requested frequency bands. For GSM Rxlev/RxQual/CelliD, for UMTS RSCP/EcNo/SC and for LTE RSRP/RSRQ/PCI.

113. Thresholds will be defined according to the design and displayed per parameter in the legend and marked with different colors in measurement reports.

114. Measurement equipment utilized, calibration due dates and types of software, will be mentioned in the report

115. Measurement reports can be a part of the protocol of acceptance between PO and MNO.

5.2.1 P-DAS underperformance

116. Where the coverage or link loss fails to meet the requirements of this document (based on any verification test), the NHC shall carry out an investigation to identify the cause(s) of the shortfall. Where the shortfall is due to the design, the NHC shall seek a resolution. Where the rectification is not possible, a concession has to be submitted to the MNOs for an approval. Where the shortfall of the system is due to the installation, no concession will be accepted, and the NHC shall get the system fixed prior to the MNO base station integration.

5.3 BASE STATION INTEGRATION AND LIVE COVERAGE VALIDATION

117. The NHC may provide logistical support to the MNO carrying out the base station integration, if the assignment of the PO towards the NHC allows for such support.

118. It is the MNO's responsibility to conduct last interface connections from the P-DAS to their own base stations with correctly labelled cables.

119. The PO shall assist the site access for the MNO to carry out post-integration coverage and service surveys.

120. If an individual MNO requires the NHC to carry out the post-integration coverage and service surveys, it will be a separate agreement between the NHC and that specific MNO. Remark: With a network scanner, all networks can be measured simultaneously. Signal distribution, signal level and signal quality can be measured on all frequency bands for all MNOs.

ABBREVIATIONS

3GPP	3rd Generation Partnership Project
ACI	Adjacent Channel Interference
ACIR	Adjacent Channel Interference Ratio
ACLR	Adjacent Channel Leakage Ratio
ACS	Adjacent Channel Selectivity
A-DAS	Active Distributed Antenna System
BCCH	Broadcast Control Channel
BTS:	Combined Base Transceiver Stations per MNO
C/N	Carrier-to-Noise
CPICH	Common Pilot Channel
CW	Continuous Wave (i.e. constant power and amplitude)
DAS	Active and Passive Distributed Antenna System
dBi	Decibels relative to the gain of an isotropic antenna
dBm	Decibels relative to a milliwatt
DECT	Digital Enhanced Cordless Telecommunications
DIN	Deutsches Institute for Normierung (Germans Standards Institute)
DL	Downlink
Eb/Io	Energy per bit/total received signal
Ec/Io	Energy per chip/ total received signal
EIRP	Effective Isotropic Radiated Power
EMF	Electromagnetic Fields
ER	Exposure Ratio
ETSI	European Telecommunications Standards Institute
EVM	Error Vector Magnitude
FDD	Frequency Division Duplex
GSM	Global System for Mobile Communication
GSM-R	GSM-Railway
HOT	Heads of Terms
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEE	Institution of Electrical Engineers
LOI	Location of Interest
LTE	Long Term Evolution
MAINS PSU:	NHC Mains Power Supply Unit
M&E	Mechanical and Electrical
MER[2]	Main Equipment Room
MBSFN	Multimedia Broadcast multicast service Single Frequency Network
MCL	Minimum Coupling Loss
MIMO	Multiple Input Multiple Output
MNO	Mobile Network Operator
MNO PSU:	MNOs Power Supply Unit(s) for BTS and NTE per MNO
MT	Mobile Terminal
NDA	Non-Disclosure Agreement
NTE:	Network Transmission Equipment for connecting the traffic to the core network, (can be more than one) per MNO

[2] The NEN- EN 50173 and 50174 also defines locations which can be applicable. For example MER is called Building Distribution (DB) and SER is called Floor Distribution (FD).

NGR	National Grid Reference
NHC	Neutral Host Contractor
NMAS	National Measurement Accreditation Service
PCDE	Peak Code Domain Error
P-DAS	Passive Distributed Antenna System
PMR	Private Mobile Radio
PO	Property Owner
POI	Point of Interconnect
ppm	Parts per million
RBS	Radio Base Station
RE	Resource Element
RF	Radio Frequency
RI	Radiating Infrastructure
RRH	Remote Radio Head
RRU	Remote Radio Unit
RS	Reference Signal of LTE
RSCP	Received Signal Code Power
RSRP	Reference Signal Received Power
SAR	Specific Absorption Rate
SAT	System Acceptance Test
SISO	Single Input Single Output
SER[3]	Satellite or Secondary Equipment Room
SIMO	Single Input Multiple Output
SLA	Service Level Agreement
TDD	Time Division Duplex
TRX	Transceiver
UL	Uplink
UMTS	Universal Mobile Telecommunications System
UWB	Ultra Wide Band
VSWR	Voltage Standing Wave Ratio
WCDMA	Wideband Code Division Multiple Access
WLAN	Wireless Local Area Network

[3] The NEN- EN 50173 and 50174 also defines locations which can be applicable. For example MER is called Building Distribution (DB) and SER is called Floor Distribution (FD).

APPENDIX A1 – SPECTRUM OVERVIEW (NORMATIEF)

The current Dutch MNOs have licenses to operate across multiple frequency bands. These licenses are technology neutral, with Dutch MNO all deploying 3GPP specified technologies. These current technologies (GSM/EDGE, UMTS/HSPA, and LTE FDD and TDD, including NB-IoT and LTE-M) can be distributed over any bands licensed to the respective MNO. This distribution can change over time. In the near future (planned 2019) a spectrum auction will make additional spectrum available, as such further recommended bands are noted.

It furthermore needs to be noted, that subscribers of the MNO have mobile terminals (handsets, IoT devices, …) that do not support all bands and all technologies, but shall require a need of service. Therefore this requirement should be taken into account when designing a P-DAS.

To ensure the P-DAS has sufficient flexibility for the next five years the following bands for MNO operation need to be supported in the P-DAS.

Mandatory:

Band numbers indicated below are the LTE band numbers as specified in 3GPP except for the3.5 GHz and 26 GHz bands where NR band numbers are given. Please note these bands may have different numbering for other technologies (e.g. 2G, 3G, 4G, NR).

Common name:	**Uplink:**	**Downlink:**
20 800 MHz:	832 MHz – 862 MHz	791 MHz – 821 MHz
8 900 MHz:	880 MHz – 915 MHz	925 MHz – 960 MHz
3 1800 MHz (excl. P-GSM/P-LTE):	1710 MHz –1780 MHz	1805 MHz – 1875 MHz
1 2100 MHz:	1920 MHz – 1980 MHz	2110 MHz – 2170 MHz
7 2600 MHz FDD:	2500 MHz – 2570 MHz	2620 MHz – 2690 MHz
38 2600 MHz TDD:	2570 MHz – 2620 MHz	2570 MHz – 2620 MHz

Recommended:

28	700 MHz: (planned auction 2019):	703 MHz – 748 MHz	758 MHz – 803 MHz
32	1400 MHz (planned auction 2019):	N/A	1452 MHz – 1496 MHz
N78	3500 MHz	3400 MHz – 3600 MHz	3400 MHz – 3600 MHz
	3600 MHz	3800 MHz	3600 MHz – 3800 MHz

Information:

	2300MHz	2300 MHz – 2400MHz	
N258	26 GHz	24.25 GHz – 27.5 GHz	24.25 GHz – 27.5 GHz

Note 1: The 2600 MHz FDD and TDD allocation in the Netherlands deviates slightly from European mainstream. This should not impact the P-DAS, and is handled by the MNOs connecting it. Specifically, the blocks 2565-2570 and 2685-2690 are allocated as restricted unpaired (TDD) slots, so *de facto* guard bands.

Note 2: 3500 en 3600 MHz is under governmental evaluation. Possible allocation from early 2020s.

Note 3: It is assumed that the addition of support for bands above 2600 MHz has a cost impact. This is especially true for the 26 GHz band.

Current guidelines in the ICNIRP standard

at input POI	Minimum	Maximum
Composit power per carrier for coverage	40 dBm	43 dBm

	Available spectrum blocks (License)		
Frequency Band (MHz)	**KPN**	**Vodafone**	**T-Mobile**
800	2	2	2
900	2	2	3
1800	4	4	6
2100	4	4	5
2600 FDD	2	6	5
2600 TDD	6	0	5

Per sector at input POI

	Practical carriers			For ICNIRP calculations Total Composit Power (dBm)			For ICNIRP calculations Total Composit Power (W)			Total	
Frequency Band (MHz)	**KPN**	**Vodafone**	**T-Mobile**	**KPN**	**Vodafone**	**T-Mobile**	**KPN**	**Vodafone**	**T-Mobile**	***Watt***	***dBm***
800	not	not	1x LTE(10)	0	0	43	0	0	20	20	43
900	1xUMTS(5)	2xGSM	1xLTE(10)+1xUMTS(5)	43	46	46	20	40	40	100	50
1800	1x LTE(20)	1xLTE(20)	2xGSM+1xLTE(20)	43	43	47,8	20	20	60	100	50
2100	1xUMTS(5)	1xLTE(15)	1xLTE(10)+2xUMTS(5)	43	43	47,8	20	20	60	100	50
2600 FDD	1xLTE(10)	1xLTE(20)	1x LTE(20)	43	43	43	20	20	20	60	47,8
2600 TDD	not	not	not	0	0	0	0	0	0	0	0

At >10 dB P-DAS loss from POI to antenna input and antenna gain = 2 dBi, ICNIRP compliancy for common public is valid for antenna distance of >30cm.

Advice: For BTS adjustments and quality measurements, a -20 dB tapper should be installed directly via a short jumper between every used POI output port and the P-DAS.

APPENDIX A2 – SPECTRUM OVERVIEW (INFORMATIVE)

This Appendix lists (in a non-exhaustive way) a number of systems and relevant spectra that may be considered for inclusion on the P-DAS.

Common name	**Frequency band**
C2000	380-395 MHz
Porto UHF analog	420-470 MHz
TETRA porto UHF-L	410-430 MHz
TETRA porto UHF-H	450-470 MHz
LORA	868 MHz
Private GSM/LTE	UL: 1780-1785 MHz DL: 1875-1880 MHz

Note: Further private spectra may become available for company networks.

Other radio systems that may be present in the building.

Common name	**Frequency band**
DECT	1880-1900 MHz
WIFI 2.4 GHz	2400-2500 MHz

Technology that may impact ICNRIP calculations in case DIGITENNE is installed in the vicinity of the building.

Common name	**Frequency band**
DIGITENNE	470-790 MHz

APPENDIX B - GUIDELINES ON THE GENERATION OF SURVEY ROUTES

Below, guidance is given on the generation of survey routes which shall be agreed with the participating MNO. The NHC shall use common sense bearing in mind the main objective of the testing is to verify that the P-DAS will deliver the required signal level to mobiles used by the general public and other users. Where the guideline is not possible, the NHC should use common sense proposing alternatives.

C.1 Passages ≤ 7 meters wide

Passages not more than 7m wide shall be surveyed along a route defined by the center-line of the passage with a tolerance of ± 1m.

C.2 Passages >7 meters wide

Passages wider than 7m shall be surveyed along routes on both sides of the passage at a distance of ≥1 m from the passage walls.

C.3 Rooms ≤ 5 meters wide

Rooms with an average width of not more than 5m shall be surveyed on routes around the internal perimeters, at a distance of ≥1m from the perimeter wall. Where this route is not accessible, the nearest publicly accessible route shall be taken.

C.4 5m < Room width ≤ 10m

Rooms with an average width of between 5 and 10m shall be surveyed on routes around the internal perimeters, at a distance of ≥1m from the perimeter wall and along a center-line parallel to the longest wall of the room. Where this route is not accessible, the nearest publicly accessible route shall be taken.

C.5 Room width >10m

Rooms with an average width greater than 10m shall be surveyed on routes around the internal perimeters, at a distance of 2±1m from the perimeter wall and along zigzag route sweeping the floor area. The pitch of the zip-zap route shall be not more than 4m. Where this route is not accessible, the nearest publicly accessible route shall be taken.

C.6 Stairs and elevators

Stairs and elevators shall be surveyed along the center-line of the stair or elevator. Where multiple stairs or elevators are located within the same passage way or bore, the survey routes shall be along the stair or elevator located nearest to the center-line of the passage way or bore. Where stairs and elevators are contained within separate passage ways or bores, they shall be treated as separate stairs and elevators.

C.7 Port of entry (entrances and exits)

Entrances and exits shall be surveyed along a center-line route normal to the entry or exit doorway, or as near as is practically possible by the general public. The route shall be extended to at least 20m on either side of the port of entry.

C.8 Building perimeter

The perimeter of the building shall be surveyed along the nearest publicly accessible route. Surveying is not required if the nearest publicly accessible route is over 50m from the building perimeter. All sections of road highway which falls within 100m of the building perimeter should be surveyed for leakage assessment purpose.

In all the above cases, where obstacles prevent or impede public access, the nearest publicly accessible route shall be taken to get back onto the defined survey route.

C.9 Car park

Car parks shall be surveyed using a typical saloon vehicle along all designated entrance, throughway and exit routes, utilizing measurement equipment inside the vehicle placed at dashboard height, consideration to be taken for vehicle average penetration loss of 7dB.

APPENDIX C (NORMATIVE): APPLICABLE TECHNICAL AND REGULATORY DOCUMENTS.

Below, a list of rules and regulations is provided in which a description is given of the conditions that are imposed on MNOs by the local, national and European regulators at the date of writing of this document. In addition, technical specifications apply. By its very nature, this list is non-exhaustive and subject to change. It is highly recommended to contact MNOs in order to verify whether additional requirements need to be taken into account.

3GPP

The technical specifications for the 2G, 3G, 4G and (soon) 5G technologies used by the MNOs are specified by 3GPP (www.3gpp.org, http://www.3gpp.org/specifications/specification-numbering). In the context of the Dutch operators Indoor Technical Specification (**DITS**) the specifications of special relevance are the ones describing the radio aspects of terminals and base stations. These do impact the P-DAS design. It should be noted 3GPP does evolve (in Releases) and maintain its specifications. It is advised to consult one of the latest "frozen" Releases for these specifications, e.g. Releases 12-14. The DITS includes a number of the relevant parameters from these documents in the main body.

2G:

45-series, especially:
45.005: GSM/EDGE Radio transmission and reception
45.008: GSM/EDGE Radio subsystem link control
45.010: GSM/EDGE Radio subsystem synchronization

3G

25-series, especially:
25.101: User Equipment (UE) radio transmission and reception (FDD)
25.104: Base Station (BS) radio transmission and reception (FDD)

25.113: Base station (BS) and repeater electromagnetic compatibility (EMC)
25.133: Requirements for support of radio resource management (FDD)

4G:

36-series, especially:
36.101: Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception
36.104: Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception
36.113: Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements for support of radio resource management
36.133: Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements for support of radio resource management

Multi-standard radio:

37-series, especially
37.104: E-UTRA, UTRA and GSM/EDGE; Multi-Standard Radio (MSR) Base Station (BS) radio transmission and reception
37.113: E-UTRA, UTRA and GSM/EDGE; Multi-Standard Radio (MSR) Base Station (BS) Electromagnetic Compatibility (EMC)

ETSI:

The above 3GPP specifications also are available as ETSI specifications. The key difference is that ETSI versions have a leading 1 in front of the specification number (3GPP 36.101 = ETSI 136.101), and are available later than in 3GPP as a consequence of transposition times.
In addition to the specifications, ETSI also produces standards based on these specifications, and based on the European standardization mandate it has from the EC. Here the version of the relevant part published in the OJEC applies:
ETSI EN 301 908 IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU

Part 1: "Introduction and common requirements";
Part 2: "CDMA Direct Spread (UTRA FDD) User Equipment (UE)";
Part 3: "CDMA Direct Spread (UTRA FDD) Base Stations (BS)";
Part 13: "Evolved Universal Terrestrial Radio Access (E-UTRA) User Equipment (UE)";
Part 14: "Evolved Universal Terrestrial Radio Access (E-UTRA) Base Stations (BS)";
Part 18: "E-UTRA, UTRA and GSM/EDGE Multi-Standard Radio (MSR) Base Station (BS)";
These documents are regularly updated to take enhancements of work in 3GPP into account. As a consequence e.g. NB-IoT, LTE-M and NR will be added in future version.

ETSI EN 301 511 Global System for Mobile communications (GSM); Mobile Stations (MS) equipment; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU
ETSI EN 301 502 Global System for Mobile communications (GSM); Base Station (BS) equipment; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU

Regulatory
Competition law:

- Dutch Competition Act (*Mededingingswet*) and Act Establishing the Authority for Consumers and Markets (*Instellingswet ACM*)

Telecommunication laws and regulations:

- Dutch Telecommunications Act

  The latest version is to be applied at all times. The version in force 31.03.2018 can be found at: http://wetten.overheid.nl/BWBR0009950/2018-03-31
- Telecommunications Act BES
- Governmental decrees concerning the telecommunications market, such as, but not limited to, Decree alternative distribution numbers, Decree verification legal entities, Decree interoperability and Decree payments Telecommunications Act.
- Ministerial Appendices, such as, but not limited to, Regulation universal service provision and end users interests, Regulation auction procedure and drawing lots procedure numbers and Regulation written notification;

European Laws:
There are also applicable European laws, license conditions, for example:

- Treaty on the Functioning of the European Union, specifically Articles 101, 102 and 106
- Regulations (EG) nr. 1/2003 and (EG) nr. 139/2004

- The DITS transfers responsibility from MNOs to the NHC which can be a third party. As such, some of the legislation mentioned here may also apply to the NHC and the contractual relation between NHC and PO.

License conditions:

The Dutch MNOs have licenses for their spectrum. These licenses contain restrictions on use of these licenses. It is essential these are also fulfilled when the spectrum is used over a P-DAS. The licenses are public and can be found in the Nationaal Frequentieregister (http://nfr.agentschaptelecom.nl/nfr/content/freqPortal.do) by looking for the relevant spectrum. Some of the restrictions are frequency band specific. Typical restrictions are related to in-band and out of band emissions (where conditions reflect European legislation, if applicable), emissions in special places (e.g. hospitals) or near special locations (e.g. radio astronomy), or near country borders (HCM Agreements).

EMF requirements.

1 International Commission on Non-Ionizing Radiation Protection (ICNIRP), Guidelines for Limiting Exposure to Time Varying Electric, Magnetic and Electromagnetic Fields (Up to 300GHz), Vol 74, No. 4 April, 1998.
2 BSI EN 50383, Basic standard for the calculation and measurement of electromagnetic field strength and SAR related to human exposure from radio base stations and fixed terminal stations for wireless telecommunications system (110MHz – 40 GHz)
3 IEC62232, Determination of RF field strength and SAR in the vicinity of radiocommunication base stations for the purpose of evaluating human exposure, International Electrotechnical Commission, Edition 1.0, 2011-05.
4 Directive 2013/35/EU of the European Parliament and of the Council of 26 June 2013 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agenda (electromagnetic fields), OJ L 179

Antenneregister:

The government intends to start a discussion on what needs to be included in the antenneregister. This may add requirements on a P-DAS.

R-GSM

To protect R-GSM a non-public working agreement is in place that restricts the use of the 900 MHz band near railway lines. For indoor locations where the working agreement restricts usage of 900 MHz a discussion in an early phase with the MNOs on consequences is required as MNO may not be able to couple in all frequency bands thus impacting system performance.

S-band radar

To protect S-band radars of the Ministry of Defense and Luchtverkeersleiding Nederland a non-public working agreement is in place that restricts the use of the 2.6 GHz band around S-band radar sites. For indoor locations where the working agreement restricts use of 2600 MHz a discussion in an early phase with the MNOs on consequences is required as MNO may not be able to couple in all frequency bands thus impacting system performance.

112
For emergency call purposes the MNOs need to provide location information to the Public Safety Answering Point (meldkamer). This exact detail of the required information will requested by the MNO and provided by the NHC/PO.

Regeling NL Alert
The MNOs need to know the exact location of the antennas located in a building in the P-DAS in order to decide whether or not these cells need to be included in any NL-Alert. The positions will be identified on the as built floor plan.

Note: For regulatory service 112 and NL Alert location of coverage is very relevant. MNOs assume cell coverage is NOT spread over a larger especially non-contiguous area covering multiple macrocells.

Others
NEN 1010, ISO, CENELEC, ISO norms materials, installation.

APPENDIX D MECHANICAL, ELECTRICAL, THERMAL AND RF INTERFACE SPECIFICATIONS

Mandatory agreement RF conditions at the point of interconnect (POI): 40 dBm composite power per carrier for all technologies and frequency bands (**Appendix A1**)

Maximum allowed composite input power per carrier: 43 dBm. Depending on agreed Link budget, less power is possible.

Note: please contact MNO's in case of smaller P-DAS, allowing for lower power input signals.

Main goal: Practical useable BTS room compliant for ETSI EN 300 019-1-3, class 3.1 and ARBO.

- Floor space (in m2)
- Height (in m)
- Mains power (230 V AC, current handling in Ampère)
- Ambient temperature range (e.g. 15-22 degrees)
- Humidity range (e.g. 20-80%)
- Weight capability (in kg/m2)
- Workspace
- (Emergency) Entrance,
- Wall space (in m)
- Maximum coax distance from BTS to the PoI (20m)
- Grounding
- Lightning protection

Details on the above will be provided by each MNO separately.